96TH STREET CORRIDOR STUDY

MICHIGAN ROAD TO KEYSTONE AVENUE

Prepared for:

The Indianapolis
Metropolitan Planning Organization

PARSONS
BRINCKERHOFF

December 1999

Parsons Brinckerhoff
47 South Pennsylvania Street
Suite 600
Indianapolis, Indiana 46204
317-972-1706
Fax: 317-972-1708
Toll Free: 1-888-722-1706

December 31, 1999

Mr. Steve Cunningham
Indianapolis Metropolitan Planning Organization
200 East Washington Street, Suite 1841
Indianapolis, IN 46204

Re: Final Report
96th Street Corridor Study

Dear Mr. Cunningham:

We are pleased to transmit this final report for the 96th Street Corridor Study. It addresses future land use and transportation issues for the corridor section located between Michigan Road and Keystone Avenue. The findings and recommendations of this are study were carefully developed over a period of about a year, based on technical forecasts and evaluations, extensive public input, and multiple agency involvement.

As we transmit this report, certain issues related to proposed developments in the vicinity of 96th and Meridian Streets require clarification. As this project began, a proposal was presented to the Carmel-Clay Plan Commission for a major development at this location. The proposed rezoning anticipated up to 1 million square feet of office uses and 100,000 square feet of retail uses, and was under consideration during the entire period of this study. It was ultimately withdrawn, but not until after our last public meeting in November, 1999.

The 96th Street Corridor Study was conducted in a manner which respected the role of the Carmel-Clay Plan Commission in reviewing the proposed rezoning. No official position was suggested or taken by the 96th Street Corridor Study Transportation Working Group (TWG) regarding the proposed rezoning. We assumed relatively intense development at this location (similar to the proposal) in order to reflect a "worst case" scenario for study. It was assumed that the review process of the Plan Commission would address specific access and circulation issues related to the development.

Two observations are offered to provide clarity regarding the relationship of the proposed office park development to this study and to assist in reviews of similar zoning and development proposals in the future:

1. There were divergent views among TWG members regarding the proposed development. These views were based on many considerations in addition to concerns about traffic, including density and compatibility with adjoining land use. Traffic impacts of the proposed rezoning were considered in this study, but in no way should this be considered an endorsement.

2. An important statement in this report is that traffic forecasts and recommendations of this study assume satisfactory traffic operations at the 96th and Meridian Street intersection and within the Meridian Street/I-465 interchange. Satisfactory traffic operations at these locations were never clearly demonstrated for the proposed rezoning. It is essential that these

traffic operations be specifically addressed in future studies of this location. Otherwise, 96th Street traffic demand will be higher than the estimates supporting this study and levels of service may deteriorate.

This study was unique in terms of multi-agency involvement and high level of public input, through the work of the TWG and at highly attended public meetings. The approach of sharing technical studies and findings with the TWG as the work progressed proved to be very effective in the consideration of alternatives. We recommend the use of this technique in similar analyses within the Indianapolis region.

Thank you, for the opportunity to assist the Indianapolis MPO on this important project. Should questions regarding the study arise in the future, please do not hesitate to call us.

Sincerely,

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

John W. Myers
Assistant Vice President
Area Manager

JWM:pks

Enclosure

96TH STREET CORRIDOR STUDY
MICHIGAN ROAD TO KEYSTONE AVENUE

TABLE OF CONTENTS

96TH STREET CORRIDOR STUDY
MICHIGAN ROAD TO KEYSTONE AVENUE

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

STUDY PURPOSE

The 96th Street Corridor Study was commissioned by the Indianapolis Metropolitan Planning Organization (MPO) in cooperation with the City of Indianapolis, Hamilton County and the City of Carmel. The intent of the study is to develop a long-range plan for land use and roadways within the 96th Street corridor between Michigan Road and Keystone Avenue. The study process was designed to support informed dialogue by affected citizens and agencies to provide for long term regional transportation needs and to promote community stability.

STUDY AREA

This study addresses transportation and land use conditions on and along 96th Street between Michigan Road and Keystone Avenue. (See *Figure 1-1.*) Alternative land use scenarios are evaluated for undeveloped properties fronting 96th Street to identify associated traffic impacts. Other vacant properties in the vicinity are considered in traffic forecasting, including 4,000 acres within western Clay Township of Hamilton County.

Three intersections in the corridor are under the jurisdiction of INDOT: Michigan Road (U.S. 421), Meridian Street (U.S. 31), and Keystone Avenue (U.S. 431). INDOT plans to reconstruct the 96th and Michigan Road intersection within two years. An overlay zone has been created to define land use and development standards for that area. Land use and traffic conditions between Spring Mill Road and College Avenue (including Meridian Street) are currently being considered by the Carmel/Clay Plan Commission, and the U.S. 31 EIS and design study being initiated by INDOT will include the Meridian/96th and Keystone/96th intersections. This study focuses on the portions of 96th Street between these state highway intersections.

JURISDICTIONS

Transportation

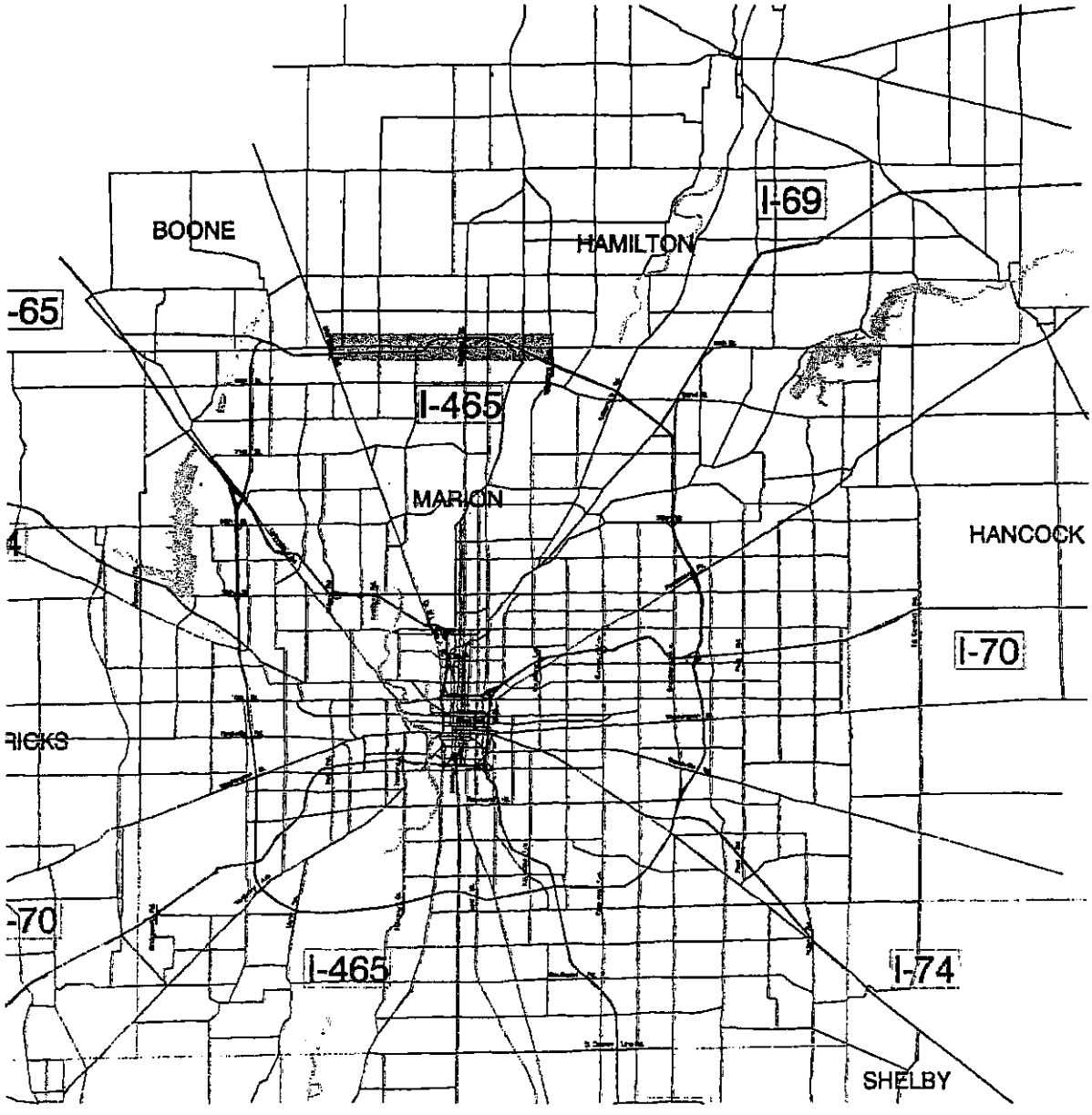
The Indianapolis Metropolitan Planning Organization (MPO) is responsible for long range transportation planning for the urbanized area, including Marion County and portions of each surrounding county. . The Indianapolis Regional Transportation Plan addresses system needs on a regional basis. Major transportation improvements that utilize federal funds must be supported by this regional plan.

In Indiana, government agencies have jurisdiction of roadways on their eastern and southern boundaries. Within this study area, 96th Street is under the jurisdiction of Hamilton County and the City of Carmel, except at the three state highway intersections listed previously.

Land Use

The Carmel/Clay Department of Community Services (DOCS) has land use planning and zoning jurisdiction for the portions of the study area north of 96th Street. The Indianapolis Department of Metropolitan Development (DMD) has land use planning and zoning jurisdiction over areas south of 96th Street.

LOCATION MAP



96TH STREET CORRIDOR

N

0 2.5 5 MILES

FIGURE 1-1

TECHNICAL WORKING GROUP

The study process has been guided and supported by a Technical Working Group composed of several agency and neighborhood representatives. The following people participated in Technical Working Group meetings during the course of this study:

Meredith Carter	Hamilton County Council
Sharon Clark	Hamilton County Commissioner
Steve Cunningham	Indianapolis MPO
Steve Engelking	Carmel Department of Community Services
Ron Griewe	Indianapolis Dept. of Capital Asset Management
John Grogan	Cedar Knolls Neighborhood Association
George Haerle	Nora Community Council
Ruth Hayes	Nora Community Council
Mike Holibaugh	Carmel Department of Community Services
Doc Mutchmore	Deerfield Neighborhood Association
Mike Peoni	Indianapolis MPO
Pat Rice	Carmel/Clay Plan Commission
Brian Shapiro	Clay West Information Council
Steve Smith	Indiana Department of Transportation
Paul Spranger	Carmel/Clay Plan Commission
Tom Stevens	Hamilton County Highway Director

The Technical Working Group met monthly from January 1999 to October 1999 to review interim work products and to provide direction to the study team.

PUBLIC PARTICIPATION

In addition to involving neighborhood group representatives on the Technical Working Group, public participation was fostered through highly publicized public meetings. Approximately 40 people attended a meeting on February 23, 1999 to learn about the project and provide input on study issues. On September 1, 1999, approximately 150 people attended a public forum where future conditions were described and alternative plans were presented. Approximately 100 people attended the third public meeting held on October 20 to present draft study recommendations.

Meeting summaries and summaries of written comments, which were submitted following the meetings, are provided in Appendix A.

2. EXISTING CONDITIONS

COMPREHENSIVE PLANS

The comprehensive plans of Carmel/Clay Township and Indianapolis address land use north of 96th Street and south 96th Street, respectively. These plans provide a regional context to guide future land use decisions. They are intended to give some predictability to each community as to where types and intensities of development might occur. In most areas, the plans provide for compatible use. In others, there are potential inconsistencies across the county line.

Carmel/Clay Comprehensive Plan

The Carmel/Clay 2020 Vision Plan identifies land use types and provides general growth policies for residential/community areas and community/regional employment areas. These policies address the intensity level, character, regional access, infrastructure support, and transition recommendations of each land use.

The majority of the land along 96th Street is zoned for and developed as residential use. Exceptions are at Michigan Road and Meridian Street, where Business Overlay Zones (BOZ) have been established. The BOZ permits developers to submit planned developments that would contain land uses not permitted by conventional zoning.

The Development Plan and Strategies U.S. 31 Highway Corridor, a special area study amendment to the 1996 Carmel/Clay Township Comprehensive Plan, provided for extensive office and limited retail development in the vicinity of 96th Street and U.S. 31. A major development (discussed throughout this report) has been proposed by Duke Realty Investments in response to that plan.

Marion County Comprehensive Plan

Marion County's Comprehensive Plan is split into sub-plans by township. The study area is included in plans for Pike Township and Washington Township. These plans provide policy and development goals, and at locations referred to as "critical areas", specific recommendations are presented to address special local issues.

Critical areas are said to warrant special emphasis because of factors related to their location, unusual character, and significant development potential. Three areas along 96th Street are deemed as critical areas and are described below:

Critical Area #1 (Meridian Corridor)

The concern in this area is the potential infringement of commercial and higher density residential development in this low density residential neighborhood. The plan identified 96th Street near Meridian Street as an area of concern due to the inconsistency of use between the Regional Commercial/Office designation in the Carmel/Clay plan and the single-family residential areas located to the south. Recommendations concerning this area include limiting commercial development to the existing Nora, Greenbriar and Meridian Street corridor.

Critical Area #2 (Keystone Corridor)

The concern in this area is the commercial concentration along Keystone Avenue next to a partially developed area of single-family homes to the west. A greater number of single-family homes is located north of 96th Street in this area. Considering neighborhood preservation and the limited roadway capacities of 96th Street and Westfield Boulevard, the Plan discourages western expansion of commercial uses along 96th Street.

Critical Area #3 (Michigan Corridor)

This area was originally developed as a single-family residential subdivision, but construction of I-465 and its interchange with Michigan Road prompted substantial retail and office commercial growth. These uses now dominate the area, with industrial uses to the west. Residential uses within this critical area are deemed to be no longer viable, although some remain. Consistent with Carmel/Clay's business overlay zone designation to the north, the Plan recommends commercial and lower intensity office uses to the west and higher intensity retail commercial uses to the east.

THOROUGHFARE PLANS

96th Street is a secondary arterial in the Marion County Thoroughfare Plan. The functional class varies within the study corridor in the Carmel/Clay and Hamilton County Thoroughfare Plans. Both identify 96th Street as a primary arterial from Meridian Street to College Avenue, and both show 96th Street as a secondary arterial from College Avenue to Keystone Avenue. Between Michigan Road and Meridian Street, Carmel/Clay has identified 96th Street as a secondary arterial and the Hamilton County plan shows it as a collector. These multiple designations within the corridor reflect the changing function of 96th Street near Meridian Street.

In the past two years, the Carmel/Clay Plan Commission amended their Thoroughfare Plan twice in this area, to incorporate the US 31 Corridor Development Plan and to adopt the recommendations of the 96th Street/Westfield Boulevard Transportation and Land Use Study.

The Hamilton County Highway Department recently completed preliminary studies for modifications to a number of intersections in the area, including 96th Street intersections with Towne Road, Ditch Road, Spring Mill Road, and Shelborne Road. The preliminary engineering process has been initiated for 96th Street improvements west of Shelborne Road. Information from these projects was made available and used in this study.

INDOT is in the final stages of design for an upgrade of U.S. 421 (Michigan Road), including reconstruction of its intersection with 96th Street. INDOT has also initiated the preparation of an EIS for upgrading U.S. 31 to a freeway, from I-465 to S.R. 38 in Hamilton County. The EIS will include 96th Street intersections with U.S. 31 (Meridian Street) and U.S. 431 (Keystone Avenue). Results from that study will not be available for two to three years.

The Regional Transportation Plan prepared by the Indianapolis Metropolitan Planning Organization includes projects of regional significance. These projects must be included in the plan to be eligible for federal funding. Generalized time frames have been identified within the 20-year context of the plan. These time frames are subject to change based on evolving network conditions and availability of funding. This plan includes the following network changes related to the study corridor:

1999-2006

Michigan Rd. – Widen to 4 lanes from I-465 to 121st St.
Meridian St. – Added turn lanes from 86th St. to 96th St.

2007-2015

Meridian St. (US 31) – Widen to 8 lanes from I-465 to Keystone Av.

2015-2020

Keystone Av. (US 431) – Widen to 6 lanes from I-465 to U.S. 31

2020+

Township Line Rd. – Widen from 2 to 4 lanes from 96th St. to 79th St.
Township Line Rd. - Extend from 79th St. to 71st St.
Towne Rd. – Widen from 2 to 4 lanes from 96th St. to 146th St.
I-465 – Widen 6 to 8 lanes from Keystone Av. to Michigan Rd.

3. RELATED STUDIES

SUMMARY OF RELATED STUDIES

Related land use and/or transportation studies involving the 96th Street corridor are numerous. They range from site-specific traffic impact studies to regional planning studies. Brief summaries are presented here for the studies most pertinent to the objectives of this study. More complete descriptions are provided in Appendix B.

96th and Westfield Boulevard Transportation and Land Use Study
Indianapolis Department of Metropolitan Development and City of Carmel
Prepared by HNTB Corporation – June 1997

This study evaluated options to address the existing jog of 96th Street where it crosses Westfield Boulevard, and it reviewed various land use options for vacant properties near the intersection.

Six alternatives for 96th Street were evaluated, ranging from localized traffic engineering improvements to construction of a new bridge to connect east and west legs of 96th Street across I-465. Assumptions were made for vacant areas south of 96th Street and four land use scenarios were developed for an 80-acre parcel at the northwest corner of 96th Street and Westfield Boulevard. Land use alternatives ranged from residential use at three units per acre to a 500,000 square foot regional office park.

This study was designed to encourage public involvement in developing recommendations. Over 100 people attended meetings to discuss the project. The overriding conclusion was that residents want to maintain the residential character of the area, as reflected in current comprehensive plans, and would prefer to make roadway changes only to the extent necessary to address local needs. Concerns were also expressed about maintaining options for the Monon Trail through the study area.

The study found that 96th Street and Westfield Boulevard would continue to operate at acceptable levels of service if the adjacent vacant land is developed as a maximum of 3 dwelling units per acre as proposed by the Carmel/Clay Comprehensive Plan.

Eight recommendations were adopted for the study. The most pertinent to this study are summarized below:

- Traffic engineering improvements should be implemented, including signalization of the Westfield Boulevard/Real Street intersection and the provision of northbound right turn lane at 96th Street.

- The option of constructing a bridge to connect 96th Street across I-465 should be retained in the event of future demand, and other bridge alternatives should be eliminated as improvement options.

- Traffic conditions on 96th Street should be closely monitored following the opening of the 96th Street bridge over White River in August, 1988.

- Plans for extending the Monon Trail and/or other planned uses of the Monon Corridor bridge under I-465 should proceed with no provision for joint use with 96th Street.

The results of the 96th and Westfield study are directly applicable to this study. As recommended, traffic counts were taken at the intersection in August, 1999 to evaluate traffic changes resulting from the construction of the new 96th Street bridge linking Keystone Avenue and I-69. (The bridge was completed in August, 1998.) Traffic volumes just east of Westfield Boulevard were found to increase about 15% during the past two years. A similar growth rate was found for north-south traffic on Westfield Boulevard, suggesting that the impact of the new bridge has not been substantial.

In response to questions regarding the potential cost for the preferred 96th Street bridge alignment of the 1997 study, an independent planning-level bridge estimate was prepared by the Indianapolis Department of Capital Asset Management. The review confirmed the previous order of magnitude cost.

This portion of 96th Street was considered in the overall context of the corridor, but respecting the high degree of public input during the previous study, and the fact that conditions have not changed significantly during the past two years, the review of options at this location was not repeated in this study.

Traffic Impact Analysis, Southwest Quadrant – I-465 and U.S. 31
Indianapolis Department of Metropolitan Development
Prepared by HNTB Corporation – April, 1998

The objective of this study was to identify the traffic and neighborhood impacts of general office zoning on the north side of 96th Street between Spring Mill Road and Meridian Street. The study considered existing and year 2007 conditions at 96th Street and Meridian Street, 96th Street and Spring Mill Road, and 91st and Street and Spring Mill Road.

The study identified the need to improve each of the three intersections under all 2007 development scenarios. The magnitude of these changes varied according to the intensity of the development. The objective was to provide a minimum level of service of "D" (See Appendix C). The most substantial changes were identified at 96th Street and Meridian Street, and these provided a lower level of service ("E") under the year 2007 scenario with major office development north of 96th Street.

More current studies based on a specific development proposal have been prepared for the same area in conjunction with a proposed development by Duke Realty Investments. Nevertheless, the 1998 study provides pertinent traffic data and a useful point of reference in reviewing 96th Street issues in this study.

Western Clay Intersection Improvement Studies
Hamilton County Highway Department
96th and Spring Mill; by American Consulting Engineers, Inc. – September, 1998
96th and Ditch; by First Group Engineering, Inc. – August, 1998
96th and Towne; by Beam, Longest and Neff, L.L.C. – October, 1998

Each of these three intersections is currently served by STOP signs with single lane approaches. All are in need of improvement. The purpose of these studies was to identify future traffic signal and roadway approach needs so that the county could move forward with project design.

Although forecasts and recommendations of these studies were reviewed, they were not incorporated directly in this study. The traffic analysis tools and design standards are the same, but traffic forecasts differ. Intersection studies typically use growth rate methods whereas the 96th Street Corridor study uses the more reliable trip generation method of traffic forecasting.

Information from these studies regarding existing traffic movements and service levels are incorporated into this study. Field survey data and right of way information was also referred to in formulating alternatives.

Traffic Impact Analysis – "The Retreat" Residential Development
Gibraltar Properties, Inc.
96th Street and Westfield Boulevard, Carmel, IN
Prepared by A & F Engineering Co., Inc. – October, 1998

This analysis was conducted to evaluate traffic effects of a proposed multi-family residential development (360 units) on the west side of Westfield Boulevard and bordering on I-465. The study area is bounded by Keystone Avenue on the east, 106th Street on the north, Westfield Boulevard on the west and Real Street on the south. The study showed that the development would generate traffic volumes comparable to those from the recommended residential land use of the 1997 96th and Westfield Boulevard Transportation and Land Use Study.

This study confirmed that the modifications to the existing system recommended in the 1997 study would be sufficient to serve traffic needs with the development in place. These improvements include the installation of a traffic signal at Real Street and the addition of a northbound right turn lane on Westfield Boulevard at 96th Street.

Traffic Impact Analysis – Village of West Clay
Towne Road and 126th Street, Carmel
Brenwick Development Company, Inc.
Prepared by Pflum, Klausmeyer, and Gehrum, Inc. – May, 1998

Although the proposed Village of West Clay is not located close to the 96th Street corridor, the traffic forecasts developed in that traffic impact study provide a useful base for estimating Hamilton County background traffic growth in this study. Those forecasts reflect build-out of approximately 4,000 acres of vacant property in Western Clay township in addition to including traffic generated by the Village of West Clay itself.

Traffic Impact Analysis – Office and Retail Development
96th and Meridian Streets, Carmel
Duke Realty Investment, Inc.
Prepared by A & F Engineering Co., Inc. – February, 1999

This TIA addressed traffic impacts along 96th Street from College Avenue to Spring Mill Road, and on Spring Mill Road and College Avenue north to 103rd Street. Existing and Year 2009 conditions were reviewed, based on 110,000 square feet of retail development, 1,325,000 square feet of office space, and a 300-room hotel and conference center.

Improvements to the intersections of 96th Street and Meridian Street, 96th Street and Spring Mill Road, and 96th Street and College Avenue were recommended to ensure that

the roadway system would operate at acceptable levels of service. These improvements included the signalization of the Spring Mill Road intersection and added through and turning lanes at all intersections. Roadway widening was recommended for 96th Street between Spring Mill Road and College Avenue. Three access points onto 96th Street were proposed between Spring Mill Road and Meridian Street, and one was added between Meridian Street and College Avenue.

According to the TIA, the level of service at the intersections studied will not change from existing conditions if the recommended improvements are made. Spring Mill Road will continue at LOS B, College Avenue will continue at LOS C, and Meridian Street will continue to operate below acceptable levels. This TIA did not review the traffic impacts of the proposed development on the I-465 interchange at U.S. 31.

During the course of the study, the proposed development changed as a result of reviews by a special committee of the Carmel/Clay Plan Commission. Retail use was reduced by 5,000 square feet, and office use was reduced by 190,000 square feet. The 96th Street Corridor Study used traffic generation estimates provided for these revised uses and densities.

4. LAND USE

EXISTING LAND USE

As shown on *Figure 4-1*, land use within the study area is almost entirely residential except where 96th Street crosses Michigan Road (U.S. 421), Meridian Street (U.S. 31), and Keystone Avenue (U.S. 431). Extensive commercial development exists or is planned near each of these intersections.

Mixed retail and office developments extend along both sides of 96th Street between Michigan Road and Shelborne Road. Comprehensive Plans in both counties recognize this as an appropriate use in this area. Similar developments exist from Keystone Avenue to Haverstick Road. Both Comprehensive Plans suggest that existing neighborhoods west of Haverstick Road be retained.

Within the Meridian corridor, proposals to extend commercial development along the north side of 96th Street westward to Spring Mill Road are currently under review by the Carmel/Clay Plan Commission. Office buildings are already the predominant use on the north side of 96th Street between Meridian Street and College Avenue.

A small retail center is located at the northeast corner of the 96th Street and College Avenue intersection, and the Five Seasons Health facility is located on the north side of 96th Street between College Avenue and Westfield Boulevard. With these exceptions, residential use extends from the commercial/retail area at the intersection of 96th and Keystone Avenue to College Avenue, and from Spring Mill Road to Shelborne Road. Except for a corner property at Meridian Street, the south side of 96th Street is also residential from Meridian Street to Spring Mill Road.

VACANT LAND IDENTIFICATION

Vacant properties within the 96th Street Corridor are shown on *Figure 4-1*. Some sites located in close proximity to each other have been considered together and are numbered as such (i.e.: 1, 1A, 1B, etc.). In all, nine sites (or site groupings) are identified as suitable for future development. Each site is described below, and a brief review is presented of zoning and surrounding land uses. Specific growth scenarios for each vacant parcel are summarized later in this chapter.

Keystone Avenue to Westfield Boulevard

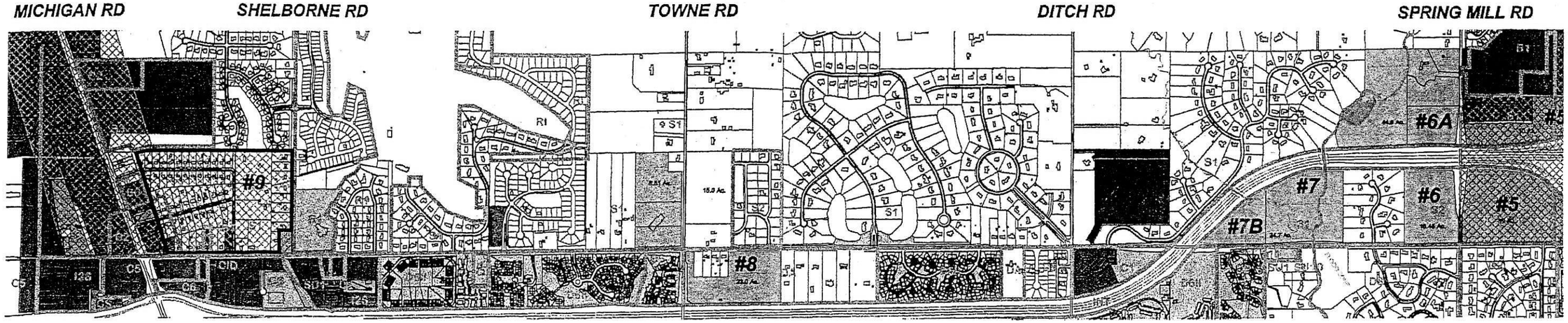
Commercial land use takes up most of the north and south sides of 96th Street from Keystone Avenue to Haverstick Road. The remainder of this section is residential in use.

Site #1:	Zoned D2 (residential, 5-15 units/acre)
Jurisdiction:	Indianapolis Metropolitan Development Commission
Area:	17.7 acres

This parcel is bounded by residential and commercial land uses to the east, I-465 to the south, I-465 and vacant land to the west and residential properties to the north. No specific proposals have been made for developing this site. Potential land use is assumed to be residential.

96TH STREET STUDY

LAND USE



ZONING LEGEND

MARION CO DISTRICTS

DWELLING	DA, DS, DP, D1-12
COMMERCIAL	CBD1-3, D1-7, C1D, CS
INDUSTRIAL	I1-5U, I1-5S
SPECIAL USE	SU1-43, PK, HD, HP, UQ

HAMILTON CO DISTRICTS

RESIDENCE	S1-2, R1-5
BUSINESS	B1-3
INDUSTRIAL	I1
MANUFACTURING	M1-3

PB PARSONS BRINCKERHOFF
47 S. PENNSYLVANIA STREET, INDIANAPOLIS, IN. 46204

NOT TO SCALE

LAND USE LEGEND

RETAIL	PUBLIC / RECREATIONAL
OFFICE	VACANT / AGRICULTURE
SINGLE FAMILY RESIDENCE	INDUSTRIAL
MULTI-FAMILY RESIDENCE	ZONING

FIGURE: 4-1

Site #2: Zoned DA (agricultural/residential, 1-2 units/acre)
Jurisdiction: Indianapolis Metropolitan Development Commission
Area: 16.2 acres

This parcel is bounded by residential and commercial uses to the east, I-465 to the south, I-465 and vacant land to the west, and residential properties to the north. No specific proposals have been made for developing this property. Potential land use is assumed to be residential.

Westfield Boulevard to College Avenue

Residential land use is most common along this section of 96th Street with the exception of the Five Seasons Sports Complex and a small commercial node at the intersection of College Avenue and 96th Street. Most residential property is single family. Two multi-family units are located on the south side of 96th Street across from the Five Seasons facility.

This section includes the only project to develop from vacant land along 96th Street during the study period. This project, a Golf-Fore-All, is located on a 23 acre parcel at the southwest corner of Real Street and Westfield Boulevard.

Site #3: Zoned S2 (single-family homes, 1-3 units/acre)
Jurisdiction: Carmel/Clay Plan Commission
Area: 69.2 acres

This parcel is bounded by residential use to the east, I-465 to the south, vacant land to the west, and a golf course to the north. Gibraltar Properties, Inc. has proposed a 360-unit multi-family development at this site, to be known as "The Retreat". It has been approved by the Carmel/Clay Plan commission and the Carmel City Council. The land use and traffic generation data from the Traffic Impact Analysis report for this project were used in developing forecasts for this study.

College Avenue to Meridian Street

The north side of 96th Street is partially developed as the Parkwood Crossing office complex. There is no residential property located there. The south side of 96th Street is predominately residential with a commercial/retail node at the intersection of 96th Street and Meridian Street. Vacant sites in this section are all on the north side, within or adjacent to the Parkwood Crossing office complex.

Sites #4, 4B: Zoned B6 (commercial/business)
Jurisdiction: Carmel/Clay Plan Commission
Area: 50.7 acres

These parcels contain the remainder of the original Parkwood Crossing development. They are bounded by commercial and residential uses to the east, residential uses to the south, vacant land to the west, and I-465 to the north. Based on prior approvals, Duke Realty Investments will complete the remainder of Parkwood Crossing, adding 333,336 square feet of office space.

Site #4A: Zoned Business Overlay Zone
Jurisdiction: Hamilton County

Area: 30.0 acres

This parcel is bound by residential land use to the east and north, I-465 to the south and office development to the west.

Site #5A: Zoned Business Overlay Zone
Jurisdiction: Carmel/Clay Plan Commission
Area: 9.6 acres

This parcel is bounded by Parkwood Crossing on the east, commercial/retail land use to the south and the I-465/Meridian Street interchange to the west and north.

Meridian Street to Spring Mill Road

The north side of 96th Street is currently vacant land through this section. The south side adjacent to Meridian Street is commercial; the rest of the south side of 96th Street is residential. Duke Realty Investment has proposed office and retail development on each of these vacant sites. The land use proposed by Duke is assumed to be in place for the purposes of traffic forecasting in this study.

Site #5: Zoned Business Overlay Zone
Jurisdiction: Carmel/Clay Plan Commission
Area: 35.0 acres

This parcel is bounded by the I-465/Meridian interchange to the east and north, commercial and residential uses to the south, and vacant land to the west. Duke Realty Investment has proposed 710,000 square feet of office space, a 300-room hotel/conference center and two 7,500 square foot free standing restaurants on this site.

Site #5B: Zoned Business Overlay Zone
Jurisdiction: Carmel/Clay Plan Commission
Area: 16.7 acres

This parcel is bounded by the I-465/Meridian Street interchange to the east and south, Spring Mill Road to the west, and office development to the north. Duke Realty Investment has proposed 425,000 square feet of office space on this site.

Spring Mill Road to Ditch Road

This area is completely residential except at the southeast corner of 96th Street and Ditch Road, where offices and an assisted living complex are located. Most are single family homes, although some multi-family residences are located on the south side.

Site #6: Zoned S2 (1-3 units/acre)
Jurisdiction: Carmel/Clay Plan Commission
Area: 16.4 acres

This parcel is bounded by vacant property (Site #5) to the east, residential uses to the south and west, and I-465 to the north. There are currently no development proposals for this property. Potential land use is assumed to be residential.

Site #6A: Zoned S2 (1-3 units/acre)

Jurisdiction: Hamilton County
Area: 16.4 acres

This parcel is bound by Site #5B and residential to the east, Site #6 to the south, residential to the west, and I-465 to the north. There are currently no development proposals, and potential land use is assumed to be residential.

Site #7: Zoned S1 (1-3 units/acre)
Jurisdiction: Carmel/Clay Plan Commission
Area: 24.7 acres

This parcel is bounded by residential properties to the east, south and west, and I-465 to the north. There are currently no development proposals, and potential land use is assumed to be residential.

Site #7A: Located in a flood plain, this parcel was deemed to be undevelopable.

Site #7B: Zoned S1 (1-3 units/acre)
Jurisdiction: Carmel/Clay Plan Commission
Area: 6.7 acres

This parcel, located adjacent and west of Site #7, currently is developed with a single family home, but could be joined with Site 7 to form a large parcel suitable for development. If this development were to occur, it is assumed that it would be residential.

Ditch Road to Towne Road

This area is completely residential. Land use is mostly multi-family residential on the south and is mostly single family residential on the north.

Site #8: Zoned DA (agricultural/residential, 1-2 units/acre)
Jurisdiction: Indianapolis Metropolitan Development Commission
Area: 23.0 acres

There are currently no development proposals for this property. Rezoning was proposed in April of 1998 from DA to D-7. The rezoning was recommend by staff (with commitments), but was denied by the Metropolitan Development Commission, citing that the "proposed land use would not be compatible and the rezoning would adversely impact adjacent properties." If development were to occur, it is assumed that it would be residential (multi-family).

Towne Road to Michigan Road

This segment is heavily multi-family on the south side and single family residential on the north side. Commercial development begins just east of Shelborne Road on the Marion County side and continues to Michigan Road. The north side of 96th Street, west of Shelborne Road, is mostly residential except at the Michigan Road intersection.

Site #9:	Zoned Business Overlay Zone
Jurisdiction:	Carmel/Clay Plan Commission
Area:	60.0 acres

This area is located within an area which is currently residential mixed with commercial land uses. Under the Business Overlay Zone designation, it is likely to continue to develop commercially. For purposes of traffic forecasting, retail and office land use is assumed at this site.

LAND USE SCENARIOS

For those sites with no current or proposed projects, the Technical Working Group reviewed potential uses and developed low, medium and high density land use scenarios for testing. These scenarios are shown in *Table 4-1*. They take into account the current zoning, the character of the surrounding areas, and potential impacts on future development along 96th Street.

96th St. Study
Land Use Scenarios Trip Generation Scenarios

Site #	Acres	Scenario #1 (Low Intensity) Land use	Density	Build-out	Scenario #2 (Medium Intensity) Land use	Density	Build-out	Scenario #3 (High Intensity) Land use	Density	Build-out
1	17.69	Condo/Townhouse	*15 units/acre*	255 units	Apartments	*15 units/acre*	255 units	Gen. Office	***7500 sq. ft./acre*	132,679 sq. ft.
2	16.25	Condo/Townhouse	*15 units/acre*	240 units	Apartments	*15 units/acre*	240 units	Gen. Office	***7500 sq. ft./acre*	121,875 sq. ft.
3	69.20	Same as Scenario #3			Same as Scenario #3			Apartments	5 units/acre	360 units
4	46.00	Same as Scenario #3			Same as Scenario #3			Office Park	7,250 sq.ft./acre	333,338 sq.ft.
4a	29.90	Same as Scenario #3			Same as Scenario #3			Medical Office	3,840 sq.ft./acre	115,140 sq.ft.
4b	4.70	Same as Scenario #3			Same as Scenario #3			Office Park	18,140 sq.ft./acre	85,250 sq.ft.
5	35.00	Office Park	10,200 sq.ft./acre	355,000 sq.ft.	Office Park	18,750 sq.ft./acre	656,250 sq.ft.	Office Park	*^20,300 sq.ft./acre*	710,000 sq.ft.
5a	9.64	Office Park Retail	5,500 sq.ft./acre	52,500 sq.ft.	Office Park	18,750 sq.ft./acre	187,500 sq.ft.	Retail	11,000 sq.ft./acre	105,000 sq.ft.
5b	16.00	Office Park	13,300 sq.ft./acre	212,500 sq.ft.	Office Park	18,750 sq.ft./acre	300,000 sq.ft.	Office Park	26,560 sq.ft./acre	425,000 sq.ft.
6	16.45	Single Family Res.	**3 units/acre*	48 units	Condo/Townhouse	*5 units/acre*	80 units	Apartments	*5 units/acre*	80
6a	44.60	Single Family Res.	**3 units/acre*	132 units	Condo/Townhouse	*5 units/acre*	220 units	Apartments	*5 units/acre*	220
7	24.70	Single Family Res.	**1.3 units/acre*	31 units	Condo/Townhouse	*5 units/acre*	120 units	Same as Scenario #2		
7a		*FLOOD PLAIN*			*FLOOD PLAIN*			*FLOOD PLAIN*		
7b	6.70	Single Family Res.	**1.3 units/acre*	8 units	Condo/Townhouse	*5 units/acre*	30 units	Same as Scenario #2		
8	22.97	Condo/Townhouse	****7.5 units/acre*	172 units	Apartments	****7.5 units/acre*	172 units	Same as Scenario #2		
9	60.00	(60%/36) Retail (40%/24) Gen.Office	*^^11,000 sq.ft./acre* ***7,500 sq.ft./acre*	396,000 sq.ft. 180,000 sq.ft.	Same as Scenario #1 Same as Scenario #1			Same as Scenario #1 Same as Scenario #1		

**Densities based on maximum allowed by current zoning.*
***Office build-out numbers based on DMD information.*
****Based on averages of surrounding developments.*
^excluding 300 Rm Hotel and (2) 7,500 sq.ft.Restaurants
^^based on proposed Duke retail development

Table 4-1

5. TRAFFIC FORECASTS

TRAFFIC FORECASTING PROCESS

Traffic forecasts for this study were developed using a methodology which is sensitive to local and regional land use changes. The year 2020 is used as the forecast year, consistent with the regional transportation plan and the traffic simulation model. The process uses existing traffic as a base, and makes adjustments for traffic generated from nearby vacant properties. An additional factor is added to account for background (or "through") traffic growth. This approach is consistent with Traffic Impact Analysis Guidelines for Developments in both Indianapolis and Carmel/Clay Township.

The steps used in this study for traffic forecasting are listed below:

1. Define existing traffic volumes (peak hours and daily).
2. Estimate background traffic by applying a growth rate to existing traffic .
3. Identify "build out" assumptions for vacant sites influencing the corridor, estimate future trips, and assign them to the roadway network.
4. Identify development scenarios for vacant sites within the corridor, estimate future trips, and assign them to the roadway network.
5. Produce total traffic forecasts by adding existing traffic, vacant site traffic, and background traffic.
6. Review and adjust for "induced" traffic (diverted from parallel routes) where appropriate.

The first three steps provide a base traffic forecast for evaluating alternative land use scenarios in steps 4 and 5. The review element of step 6 recognizes that a significant capacity increase in the corridor may draw through traffic from parallel routes such as 86th Street, 106th Street, and I-465. The Indianapolis regional travel simulation model provides an order of magnitude estimate of this effect. It also accounts for possible diversion in traffic or change in distribution in response.

The forecasting process described above is well suited to this study. It is more reliable than the growth rate method often used in intersection studies because of its direct link to land use assumptions. It is more accurate than areawide simulation modeling since it provides greater detail with respect to traffic generated from specific sites, and it produces localized turning movement estimates at intersections and drives.

Much of the data needed to apply the forecasting process is available from related studies. The most pertinent studies are summarized in Chapter 3, "Related Studies," and are more fully described in Appendix B. In addition to presenting existing traffic data throughout the corridor, traffic impact analyses for developments provide site specific traffic estimates for the uses proposed. In most cases, these traffic estimates were used as presented. In others, adjustments were made, particularly in traffic distribution, to reflect the corridor-wide context of this study.

EXISTING TRAFFIC VOLUMES

Existing traffic levels in the corridor are shown on *Figure 5-1*. This information was drawn from a number of sources, including regular traffic counting programs of Indianapolis and

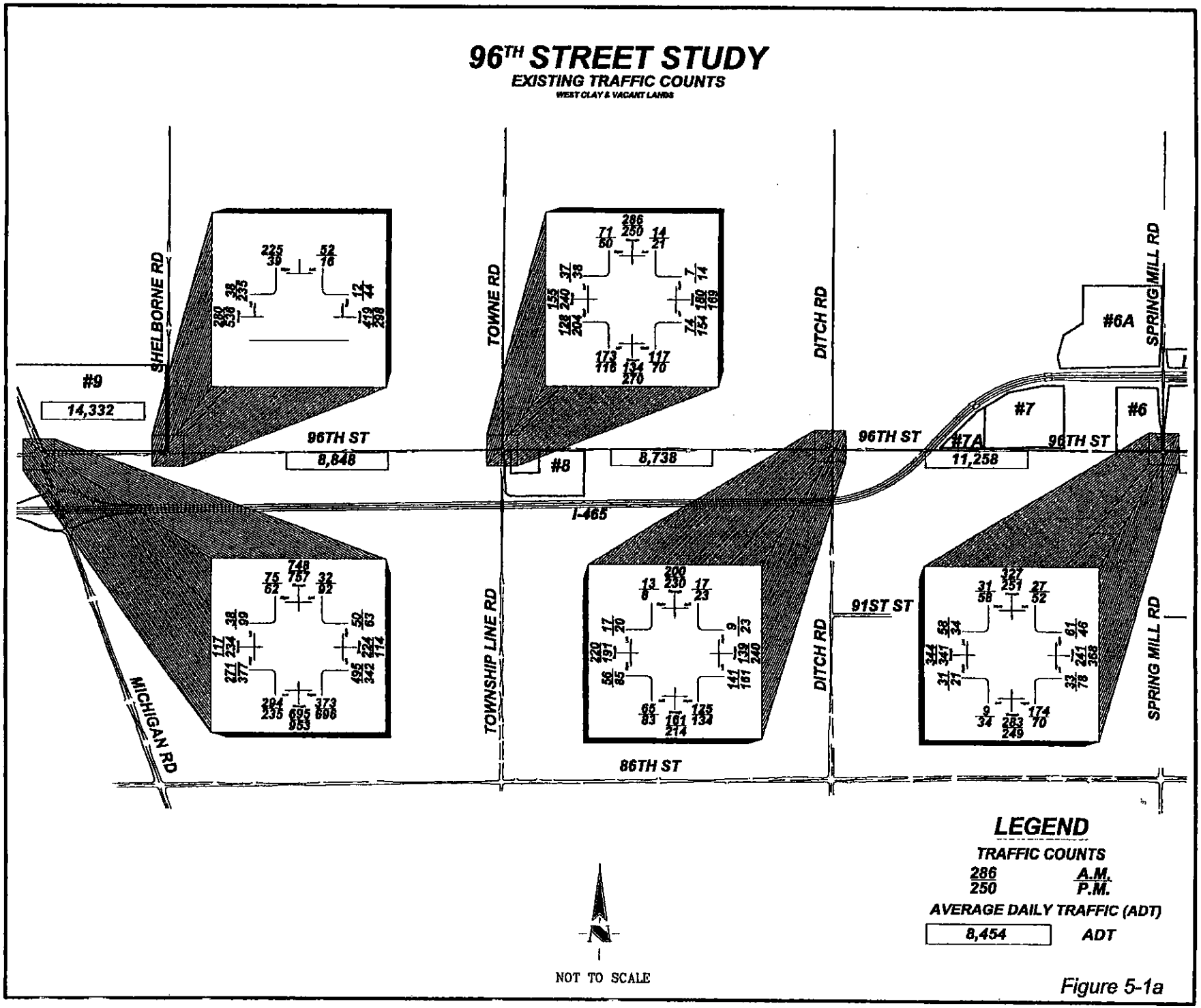
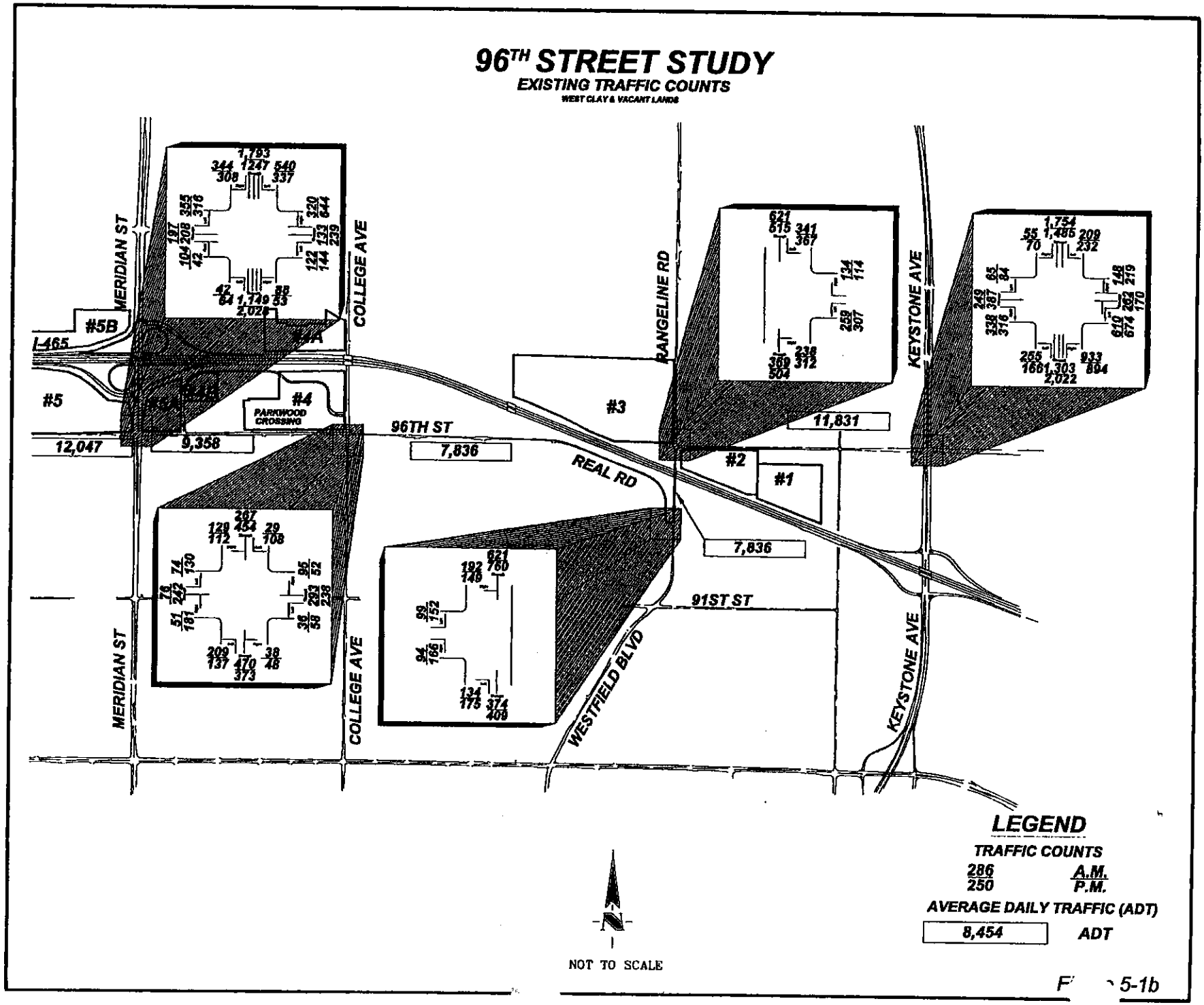

96TH STREET STUDY
EXISTING TRAFFIC COUNTS
WEST CLAY & VACANT LANDS
SHELBORNE RD
TOWNE RD
DITCH RD
SPRINGMILL RD
SPRING MILL RD
MICHIGAN RD
TOWNSHIP LINE RD
96TH ST
91ST ST
86TH ST
I-465
#6
#6A
#7
#7A
#8
#9
14,332
8,848
8,738
11,258
LEGEND
TRAFFIC COUNTS
286
250
A.M.
P.M.
AVERAGE DAILY TRAFFIC (ADT)
8,454
ADT
NOT TO SCALE

Figure 5-1a


96TH STREET STUDY
EXISTING TRAFFIC COUNTS
WEST CLAY & VACANT LANDS
MERIDIAN ST
COLLEGE AVE
RANGELINE RD
KEYSTONE AVE
WESTFIELD BLVD
I-465
96TH ST
91ST ST
REAL RD
PARKWOOD CROSSING
#1
#2
#3
#4
#5
#5A
#5B
12,047
9,358
7,836
11,831
7,836
LEGEND
TRAFFIC COUNTS
286 A.M.
250 P.M.
AVERAGE DAILY TRAFFIC (ADT)
8,454 ADT
N
NOT TO SCALE

F 5-1b

Hamilton County, Traffic Impact Analysis reports, intersection development studies, and INDOT design plans. In addition to providing a base for forecasting traffic levels, the existing data establishes relationships such as turning movement percentages and peak hour/daily traffic conversion factors.

For the purposes of this study, traffic volumes are considered "existing" if they are less than three years old. In most cases, traffic counts used in this study were taken during the past year.

VACANT PROPERTIES (OUTSIDE THE CORRIDOR)

Traffic effects from developments outside the corridor are estimated by identifying vacant properties, assuming a land use (generally as zoned), generating trips, and identifying those likely to use 96th Street for a portion of their trip.

Traffic Impact Analysis (TIA) Guidelines for Development in Carmel/Clay Township and Indianapolis require a similar approach to estimating trips from nearby vacant properties. An initial step in the preparation of a TIA is to meet with planning staffs to identify vacant areas and land use assumptions. Traffic is then generated and assigned from these sites to provide a base traffic estimate for study. In this study TIAs were drawn upon directly, where possible, to estimate traffic from vacant sites in the region. This approach provides a consistent base of data for regional planning and avoids duplication of effort.

The largest areas of vacant land which might influence the 96th Street corridor are located to the north in western Clay Township. Unlike other areas along the corridor, much of this area is largely undeveloped. Moreover, 96th Street is part of a large roadway grid which provides options for travel from Clay Township to I-465 and destinations in Marion County. Given the predominant trip patterns of the region, the traffic impacts on 96th Street could extend well beyond the 106th Street guideline originally established for this study.

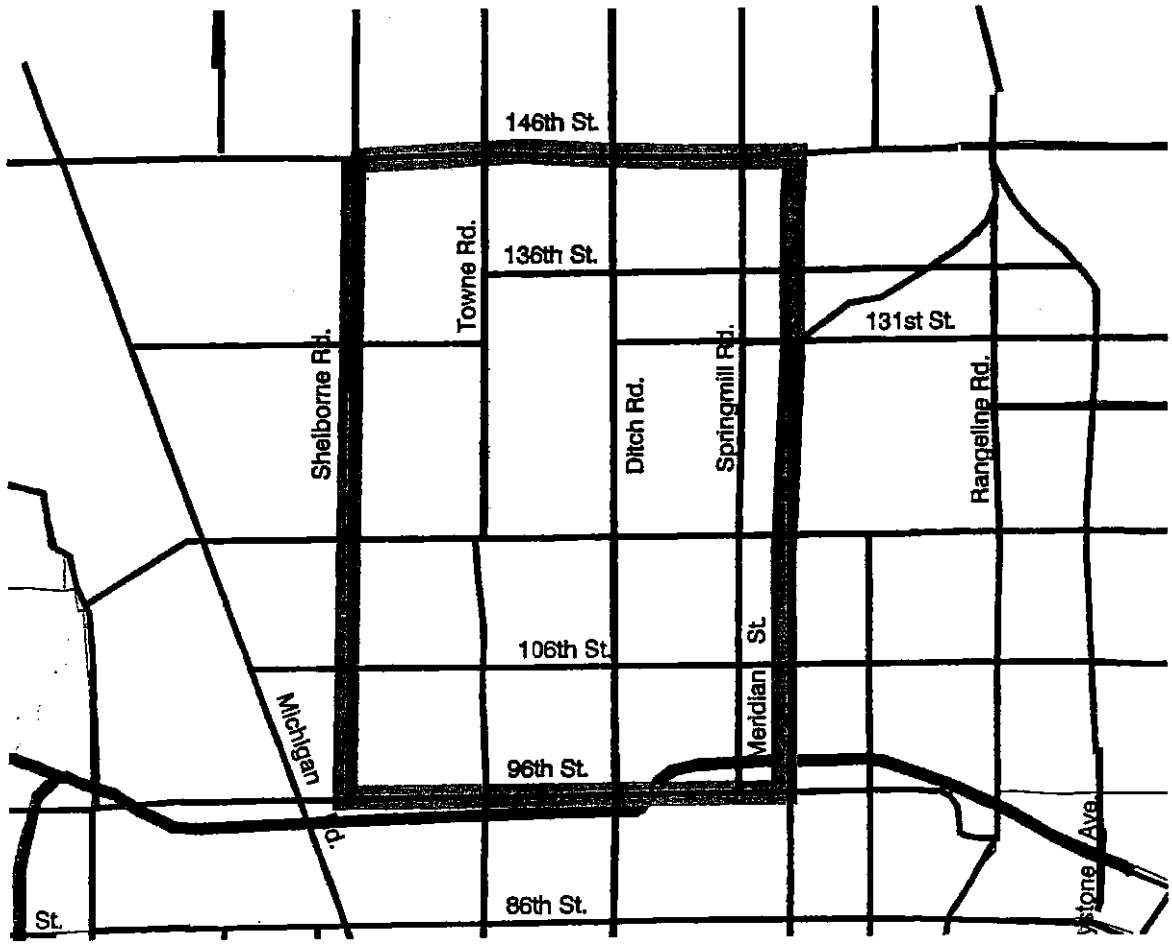
Traffic effects of growth in western Clay Township were studied in detail during 1998 as part of the TIA process for the Village of West Clay, a planned unit development near Towne Road and 126th Street (See *Figure 5-2*). Build-out of approximately 4,000 acres of vacant property in western Clay Township was assumed, in accordance with current zoning, and this was added to trips generated by the Village of West Clay. A modest background traffic estimate was developed, and all new trips were added to existing traffic to provide a total forecast for the regional network (including 96th Street). The resulting traffic assignments were used as a base for traffic estimates west of Meridian Street in this study.

VACANT PROPERTIES (WITHIN THE CORRIDOR)

Vacant properties within the 96th Street study corridor were described in the last chapter. Where specific development proposals have been made, these land uses were incorporated in this study. Since a fundamental purpose of this study is to evaluate alternative uses and their associated effects on traffic flow, a range of alternative land uses was investigated at the remaining sites. These potential uses were reviewed with the Technical Working Group to identify scenarios for testing.

The most significant proposal in the corridor is the office and retail development proposed near Meridian Street by Duke Realty Investment. This development would directly impact traffic movements on 96th Street between Spring Mill Road and College Avenue, and

VILLAGE OF WEST CLAY LOCATION MAP



West Clay Twp

Village of West Clay

N

0 .75 1.5 MILES

FIGURE 5-2

would indirectly affect remaining portions of 96th Street to the extent the corridor is used as an access route.

Through most of the course of this study, the development proposal at Meridian Street and 96th Street has been under review by the Carmel/Clay Plan Commission, and a final configuration of land use and traffic improvements is still uncertain. For the purposes of this study, future land use is assumed to be as proposed. (This is assumed to provide a "worst case" traffic scenario with respect to intensity of development.) Trip generation rates of the TIA were reviewed and deemed suitable for use in this study. Adjustments were made in distribution, however, to provide a more conservative (higher) estimate of traffic going westbound through the Spring Mill Road intersection.

Another vacant property where a TIA report was used directly in identifying future land use and forecasting traffic is the proposed residential development known as "The Retreat". This property, located at 96th Street and Westfield Boulevard, is being developed by Gibraltar Property, Inc.

Alternative uses agreed to by the Technical Working Group for the remaining vacant sites were shown on *Table 4-1*. To establish a base traffic forecast "starting point" for this study, the highest intensity use was assumed at each location. Trip generation rates were taken from the Institute of Transportation Engineers (ITE) Trip Generation Report (6th Edition).

The last component of the base traffic forecasts is background traffic. As stated previously, background traffic includes those trips within the study area which are not generated by land use within the corridor or by vacant properties where traffic is estimated directly. Essentially, these are through trips with origins and destinations outside the study area. In this study, a 1% background growth rate is assumed. This is relatively low compared to many TIA studies, but it is deemed appropriate due to the large area of vacant properties already included in the base forecast.

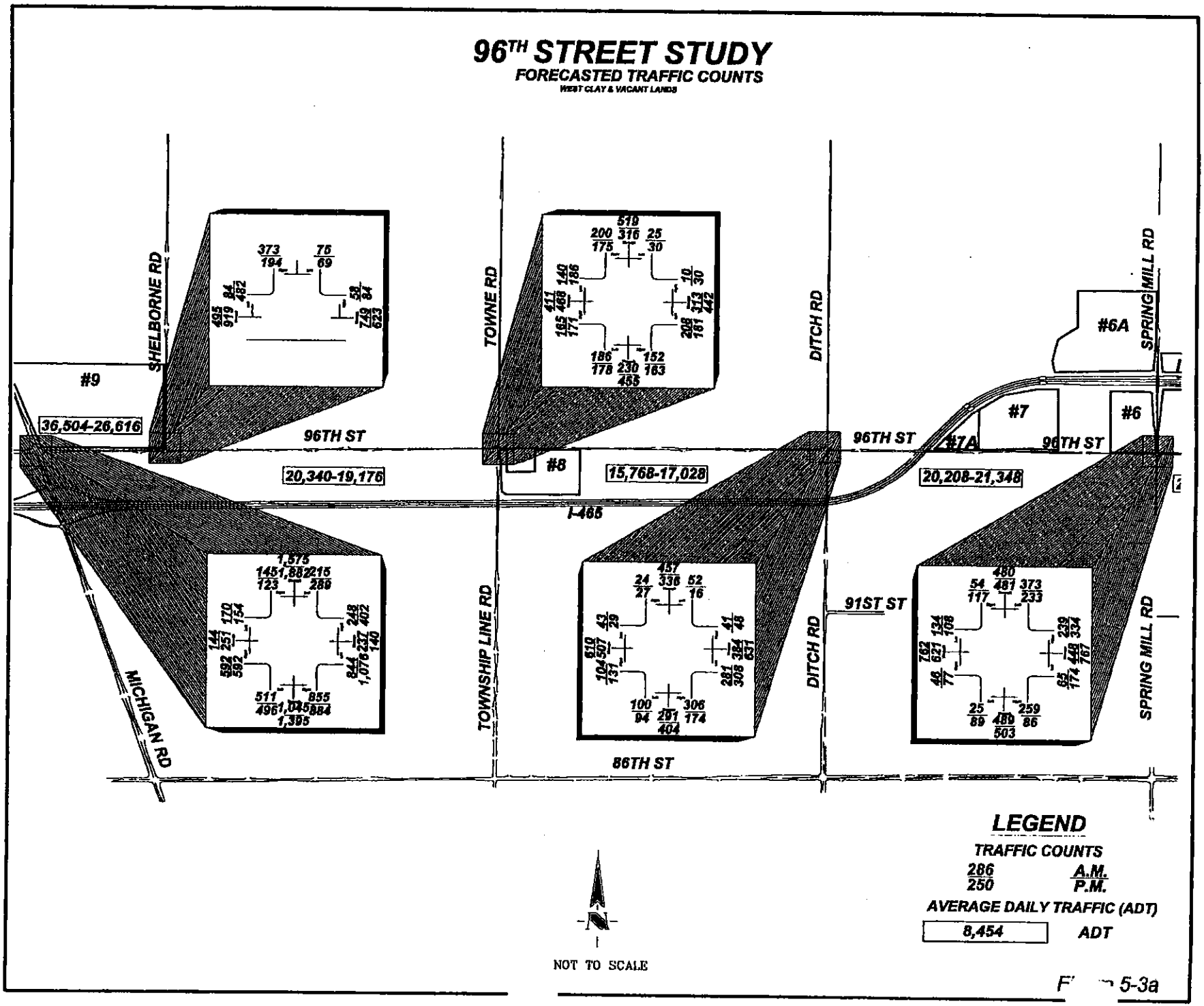
A final step in the traffic forecasting process is the conversion of hourly trips to daily traffic estimates. Generally, hourly traffic estimates are used for traffic engineering studies, including level of service analyses of intersections, and average daily traffic estimates are used for regional planning. Existing relationships between hourly and daily traffic levels were used to develop the necessary conversion factors for this study.

The result of the traffic forecasting process is shown on *Figure 5-3*. Morning and evening peak hour estimates are provided with turning movements at intersections, and average daily traffic estimates are provided on main line sections of 96th Street between intersections.

INDUCED TRAFFIC

Additional traffic may divert from parallel routes, such as 86th Street, 106th Street, and I-465, if "excess capacity" is available on 96th Street. This is especially likely given the options available to travelers in western Clay Township. The potential for this induced traffic was evaluated through use of the Indianapolis regional travel simulation model.

In reviewing induced traffic effects, it is useful to note the position of 96th Street in the region's grid system. In outlying suburban areas, previous regional transportation plans have suggested two-mile spacing for primary arterials, with intermediate secondary


96TH STREET STUDY
FORECASTED TRAFFIC COUNTS
WEST CLAY & VACANT LANDS
SHELBORNE RD
TOWNE RD
DITCH RD
SPRING MILL RD
#9
#6A
#7
#6
#7A
#8
96TH ST
36,504-26,616
20,340-19,176
15,768-17,028
20,208-21,348
I-465
91ST ST
86TH ST
MICHIGAN RD
TOWNSHIP LINE RD
LEGEND
TRAFFIC COUNTS
286 A.M.
250 P.M.
AVERAGE DAILY TRAFFIC (ADT)
8,454 ADT
NOT TO SCALE

F' 5-3a

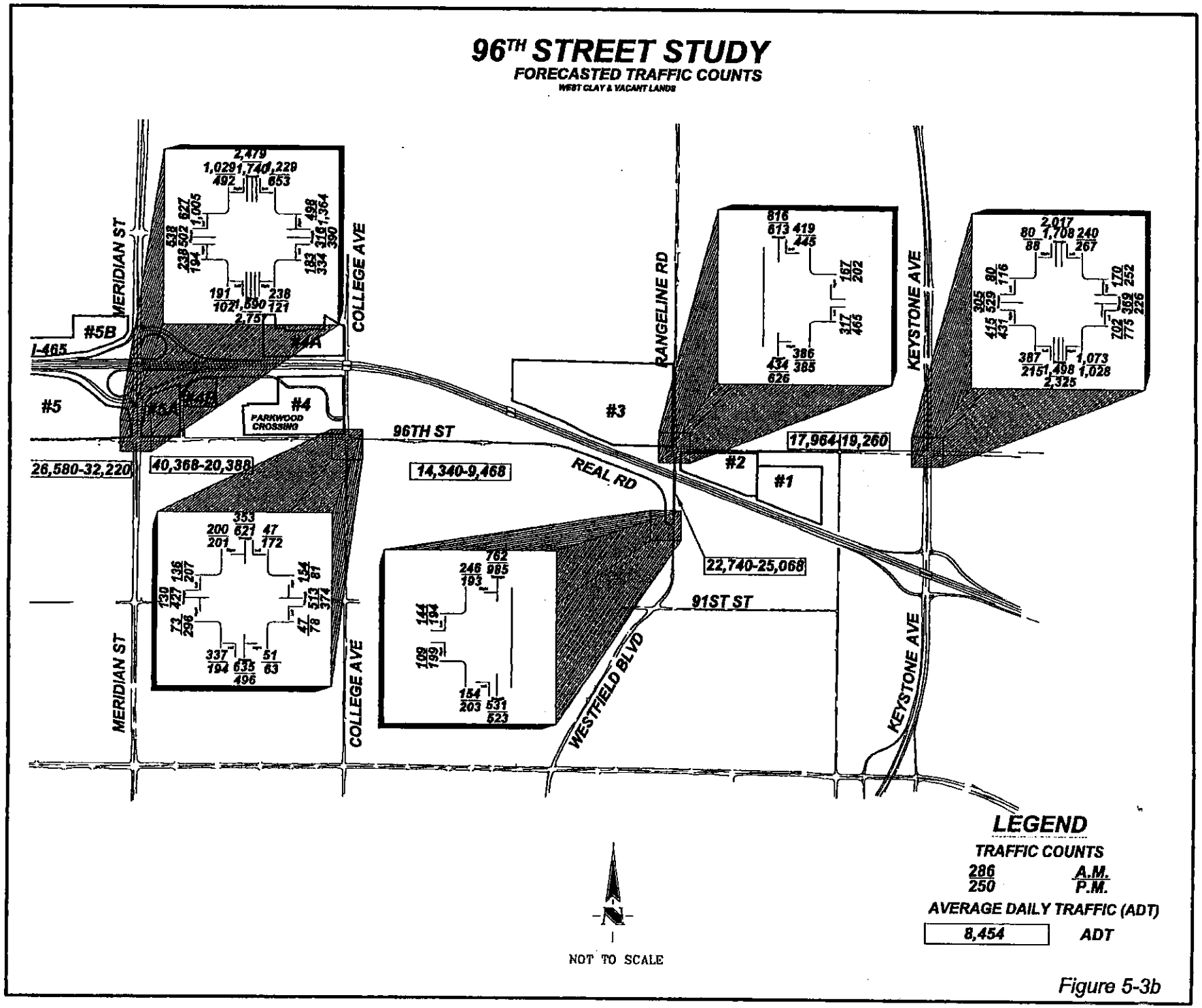

96TH STREET STUDY
FORECASTED TRAFFIC COUNTS
WEST CLAY & VACANT LANDS
MERIDIAN ST
COLLEGE AVE
RANGELINE RD
KEYSTONE AVE
WESTFIELD BLVD
I-465
96TH ST
91ST ST
REAL RD
PARKWOOD CROSSING
#1
#2
#3
#4
#4A
#5
#5A
#5B
26,580-32,220
40,368-20,388
14,340-9,468
17,964-19,260
22,740-25,068
LEGEND
TRAFFIC COUNTS
286 A.M.
250 P.M.
AVERAGE DAILY TRAFFIC (ADT)
8,454 ADT
N
NOT TO SCALE

Figure 5-3b

arterials at one-mile spacing. 96th Street lies between the primary arterials of 86th Street (one mile south) and 116th Street (two miles north).

Given the three-mile spacing of parallel primary arterials, it might be expected that 96th Street would carry more than its share of regional traffic. Existing traffic data does not support this. In fact, current traffic distributions indicate concentrations of demand at I-465 interchange locations and localized access to properties in between. There is little indication that 96th Street serves as a major east-west route for longer trips. This is reasonable given the close proximity of I-465.

As stated previously, the travel simulation model does not provide traffic forecasts at the level of detail needed for an effective corridor study. It is, however, a very effective tool for evaluating induced traffic impacts since it considers the relative attractiveness of parallel routes in assigning traffic to the network. The trip tables used in the model cover a large area of origins and destinations within the region. More importantly, the model considers available capacity in assigning trips to various routes. Running the model under different roadway improvement scenarios provides a relative measure of associated changes in regional travel patterns.

Test cases were run assigning year 2020 trip tables to networks which included 96th Street as a basic two-lane section and as a basic four-lane section. These tests indicated that with no changes in the origin and destination of trips, traffic levels would increase significantly on 96th Street if it were widened to four lanes. With this capacity available, motorists would divert from all parallel routes located between 86th Street and 116th Street, including I-465. The model indicates that induced traffic increases on 96th Street could be in the range of 70% or more, depending on the location in the corridor. This high level of induced traffic reflects a "fit" with regional travel patterns, but it does not necessarily indicate capacity deficiencies on parallel facilities.

The conclusion from traffic simulation modeling is that the widening of 96th Street to four lanes would cause a shift in regional travel patterns that is unrelated to land use. Due to its location in the region and the character of surrounding roadways, 96th Street would draw significantly higher traffic volumes if it was widened to four lanes, regardless of the type or intensity of nearby development.

EXISTING CONDITIONS

Currently, 96th Street is a two-lane roadway from Keystone Avenue to Michigan Road, except for approaches to major intersections, and a three-lane section of roadway between Meridian Street and College Avenue. Excepting state highway intersections (Michigan Road, Meridian Street, and Keystone Avenue), only two intersections within the six-mile corridor are currently signalized (College Avenue and Westfield Boulevard). The remainder of the intersections within the study area are controlled by STOP signs, most with single lane approaches from each direction.

Average daily traffic volumes on 96th Street range from a high of 14,332 (between Michigan Road and Shelborne Road) to a low of 7,836 (between College Avenue and Westfield Boulevard). With necessary auxiliary lanes at intersections, two lanes would be sufficient to handle this level of traffic on most sections of 96th Street. As with many streets and highways, the level of service on 96th Street is currently established by conditions at its intersections.

Several recent studies have identified existing intersection controls within the corridor as inadequate. Recent intersection studies by Hamilton County have confirmed that traffic signals are warranted at Shelborne Road, Towne Road, Ditch Road, and Spring Mill Road. The Indianapolis Department of Capital Asset Management has determined that a traffic signal is warranted at Real Street and Westfield Boulevard. (Real Street is an extension of 96th Street at its west approach to Westfield Boulevard.)

Since traffic signal installations are ineffective without proper channelization of approaching traffic, each intersection listed above will require significant reconstruction of entering roadways. Most will require acquisition of additional right of way. Given the high cost and disruption of this construction, care is being taken in both counties to consider future needs in designing these improvements. An effective strategy for treating these intersections is a major topic of this study.

Table 6-1 shows existing levels of service for intersections located within the study corridor. (See Appendix C for a description of levels of service and how they are derived.) As the table shows, 8 of the 10 intersections within the corridor are operating below Carmel/Clay's ordinary level of service standard of "C". Four intersections are operating below the Indianapolis standard of level of service "D". Three intersections operate at level of service "F".

These conditions suggest a need for improvement currently or in the near term. The next section reviews future needs for 96th Street.

EXISTING INTERSECTION LEVELS OF SERVICE

	AM Peak LOS	PM Peak LOS
96th St./		
Keystone Av. (SR 431)	D	F
Westfield Blvd.	B	C
Westfield Blvd.(Real St.)	B	F
College Av.	B	B
Meridian St. (US 31)	D	D
Spring Mill Rd.	C	D
Ditch Rd.	C	D
Towne Rd.	D	F
Shelborne Rd.	B	D
Michigan Rd. (US 421)	F	F

Table 6-1

With future needs and plans identified, immediate improvements can be planned as part of a longer term strategy. These opportunities are discussed in Chapter 8 as part of an implementation strategy for recommendations.

FUTURE CONDITIONS

Forecasted traffic levels for the year 2020 (and their derivation) were presented in Chapter 5. These traffic estimates provide the basis for developing and evaluating the level of service of improvement alternatives. Since the level of service is ordinarily determined by conditions at intersections, these are reviewed first. This is followed by a review of main line sections between intersections.

Signalized Intersection Alternatives

As pointed out in the last section, traffic service is already poor at many intersections within the corridor. Since forecasts indicate that traffic will increase substantially during the planning period, a no-build alternative is clearly infeasible. This section assumes signalization of all major intersections in the corridor and evaluates lane configurations to provide a minimum level of service "D", as determined by methodologies presented in the Highway Capacity Manual (HCM).

The approach used to develop intersection alternatives is to begin with the addition of a left turn lane in each direction (the practical minimum channelization for a signalized intersection) and to compute a future level of service. If an acceptable level of service is not provided, additional lanes are added and the intersection is reanalyzed. The process is repeated until the target level of service ("D" in this study) is reached.

A degree of judgement must be used in identifying lane additions which would be most beneficial for intersection operations. In some cases, needs differ during the morning and evening peak hours. In others, options exist which would provide the same levels of service. For example, additional through lanes make more signal time available to other movements. Similar effects can often be achieved regardless of which roadway receives the extra lanes. (An additional through lane could be installed either east-west or north-south at Ditch Road and College Avenue intersections with similar effect.)

Using the approach described above, a series of intersection improvements has been identified for intersections within the study area. All of these alternatives require the installation of traffic signals and auxiliary approach lanes. These alternatives are illustrated on *Figures 6-1a though 6-1e.* The resulting levels of service are shown on *Table 6-2.*

SIGNALIZED INTERSECTION IMPROVEMENTS
LEVELS OF SERVICE

	AM Peak LOS	PM Peak LOS
96th St./		
Keystone Av. (SR 431)		
Westfield Blvd.		
Westfield Blvd.(Real St.)	C	
College Av.		
Meridian St. (US 31)		
Spring Mill Rd.		
Ditch Rd.		C
Towne Rd.		C
Shelborne Rd.	C	
Michigan Rd. (US 421)		

**Draft TIA for Duke Realty Investments indicates LOS E-or- F*

Table 6-2

96TH STREET & SHELBORNE RD
SIGNALIZED INTERSECTION IMPROVEMENT

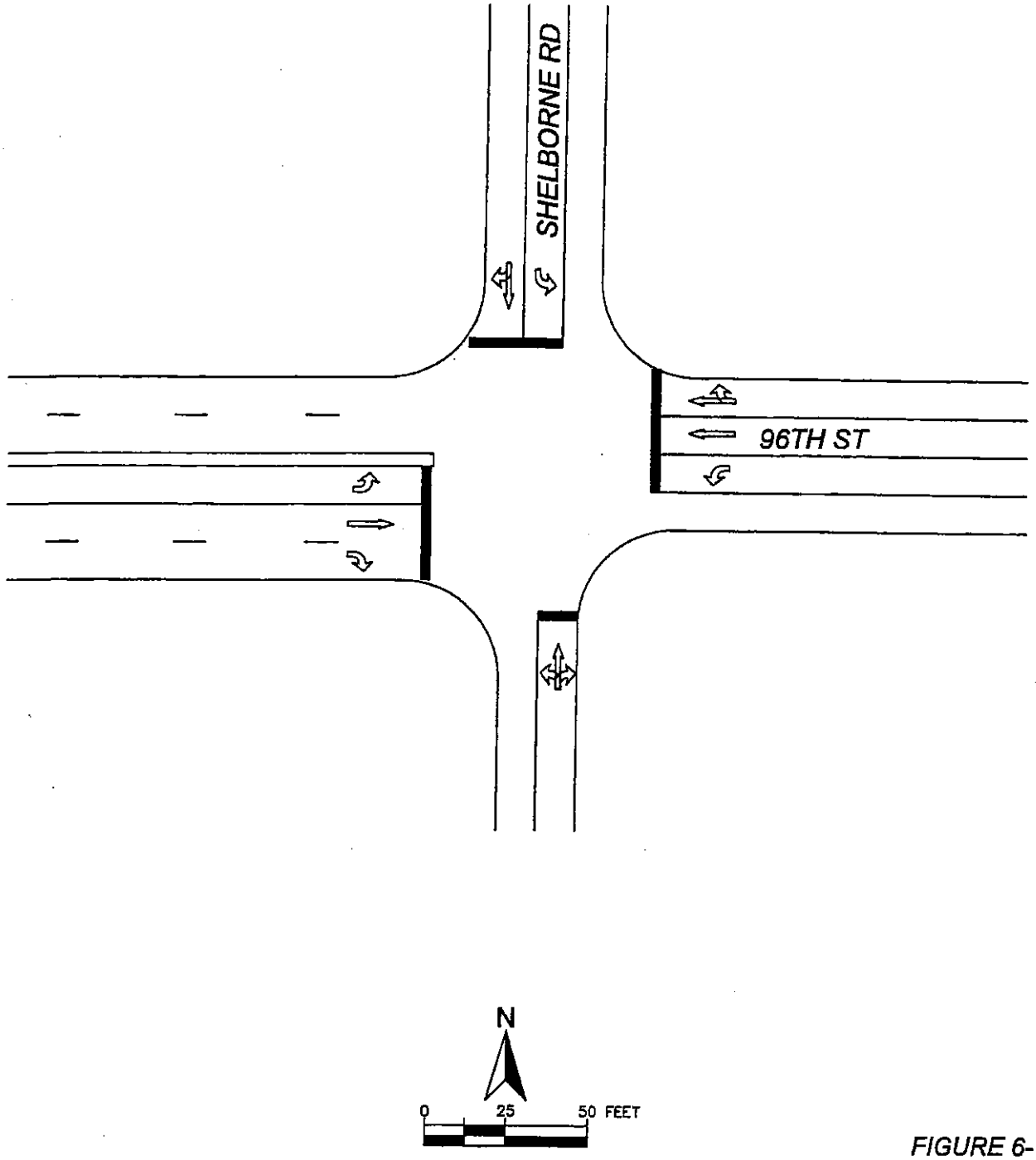


FIGURE 6-1(a)

96TH STREET & TOWNE ROAD
SIGNALIZED INTERSECTION IMPROVEMENT

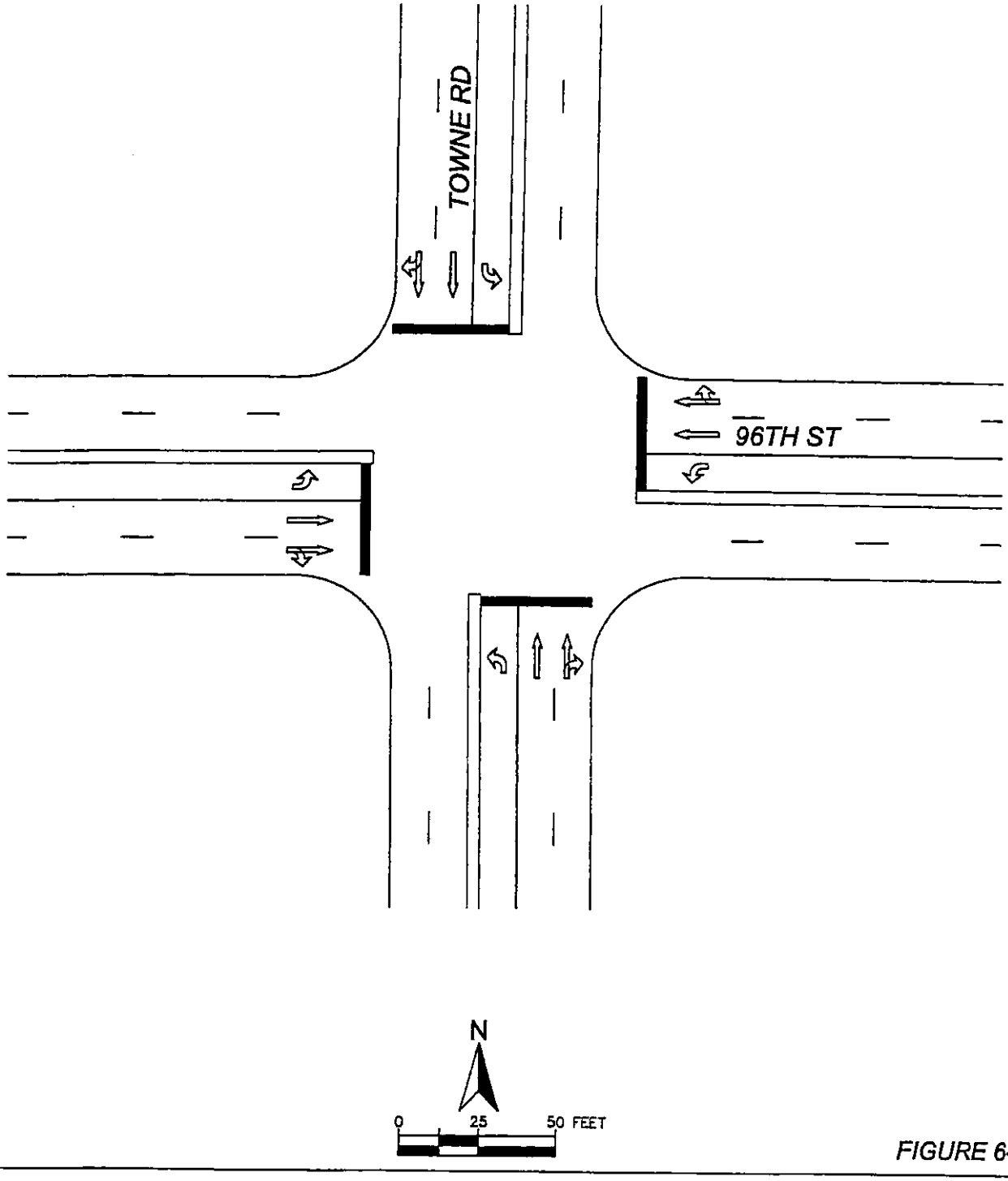


FIGURE 6-1(b)

96TH STREET & DITCH ROAD
SIGNALIZED INTERSECTION IMPROVEMENT

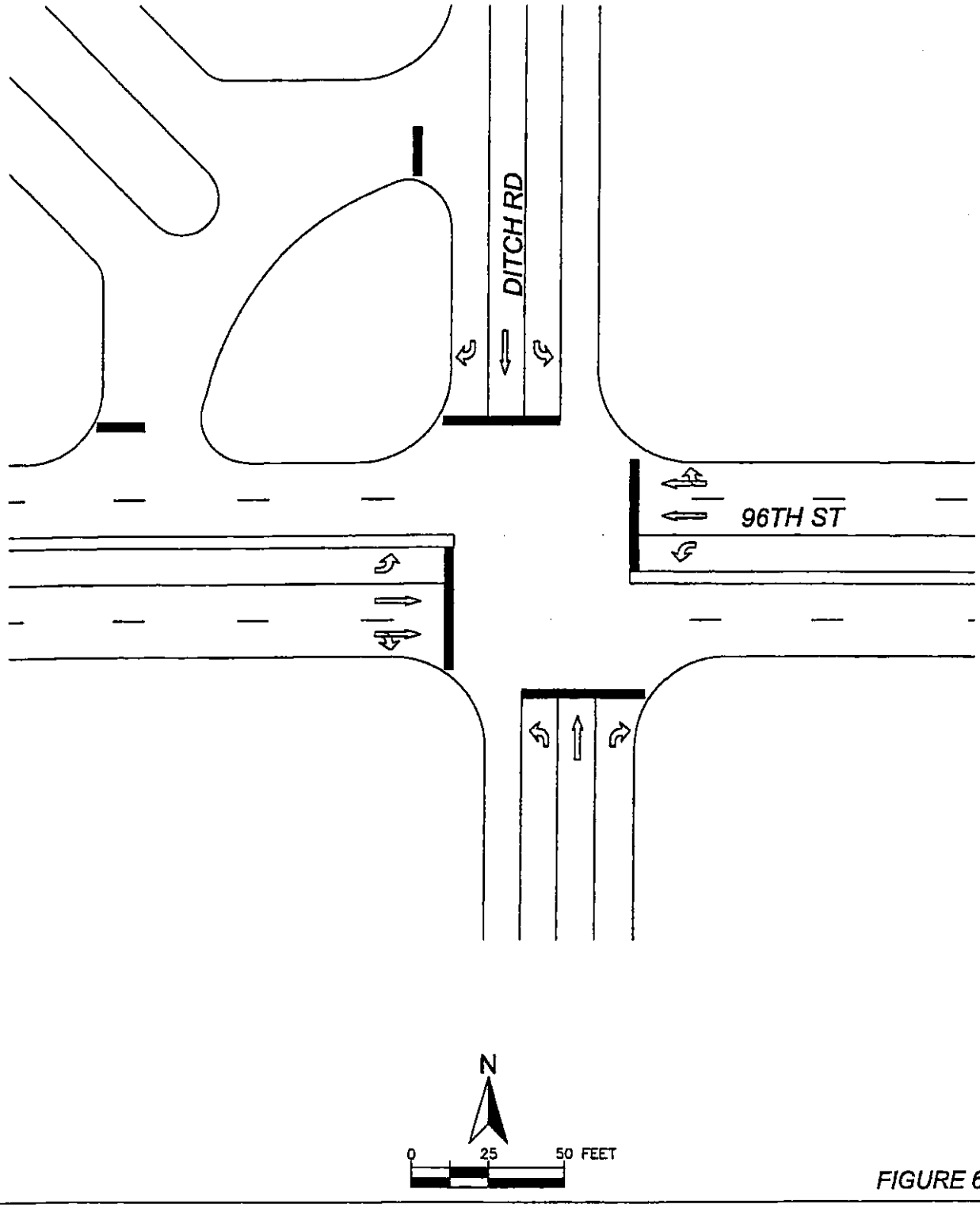


FIGURE 6-1(c)

96TH STREET & SPING MILL RD
SIGNALIZED INTERSECTION IMPROVEMENT

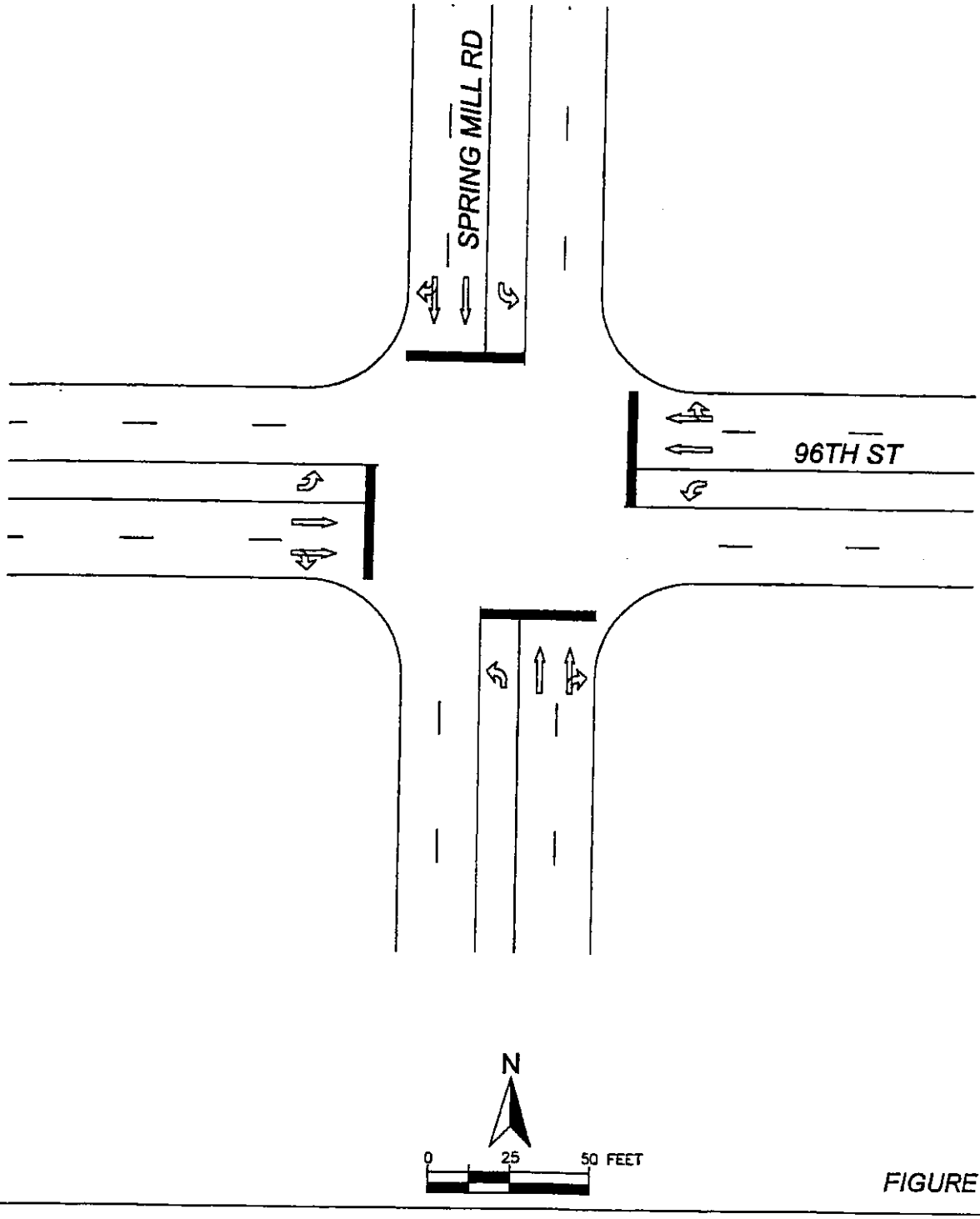


FIGURE 6-1(d)

96TH STREET & COLLEGE AVENUE
SIGNALIZED INTERSECTION IMPROVEMENT

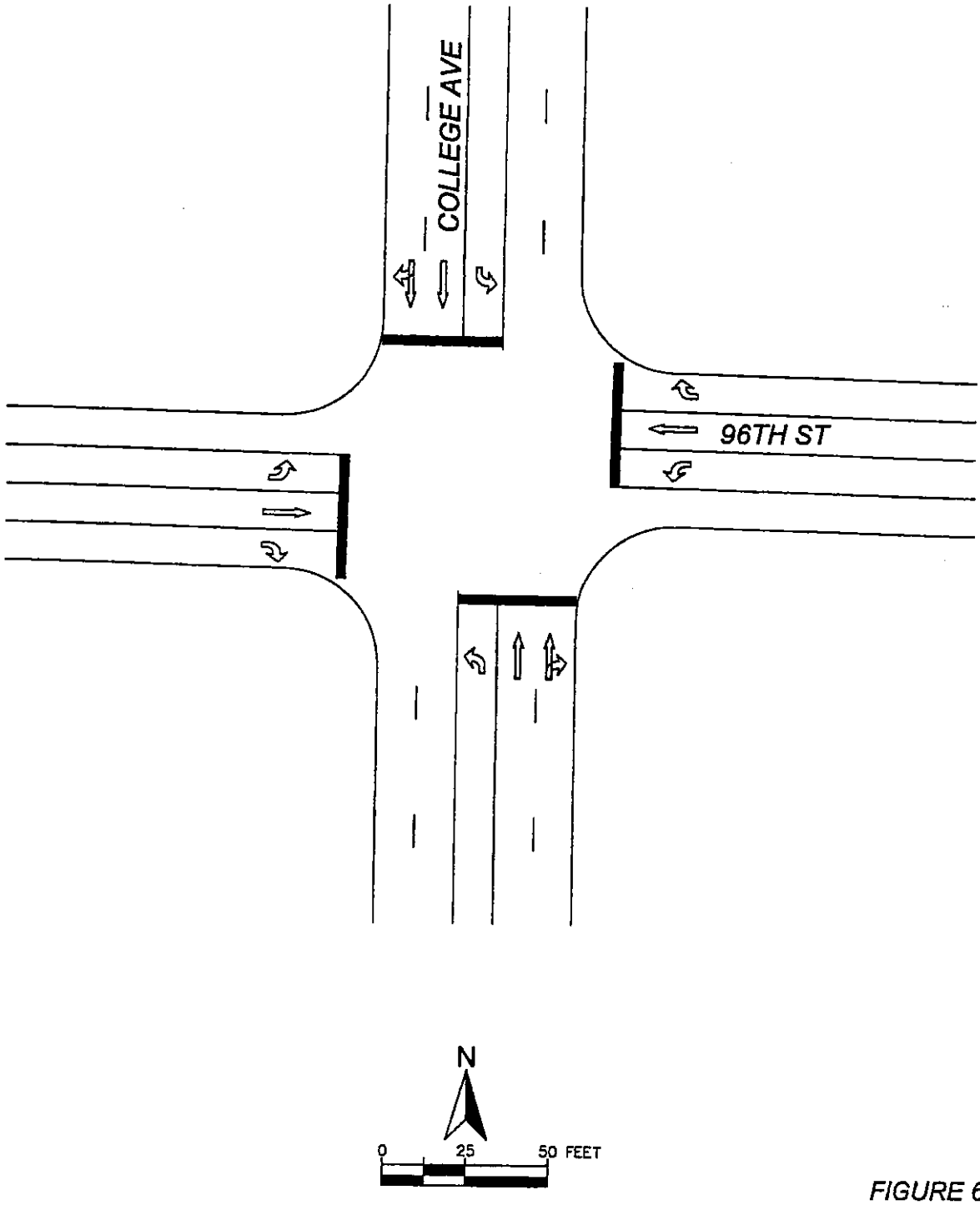


FIGURE 6-1(e)

It should be noted that the diagrams do not necessarily suggest that 4-lane cross-sections extend beyond the intersections, they could taper back to two lanes in most cases.

Roundabout Alternatives

One option which evolved during the development of this study is the provision of roundabouts in lieu of signalized intersections at selected locations. A roundabout is a form of intersection control whereby motorists from all directions merge with other traffic in a circular roadway around a small central island, and diverge to exit on the leg leading to their destination. Entering traffic yields to traffic already in the roundabout.

Experience in the UK and elsewhere in Europe suggests that the capacity of intersections and roadway sections can be balanced in a different manner using roundabouts in lieu of traffic signals. Larger areas within intersections (required for roundabouts) might be offset by reduced right of way requirements between intersections due to lower approach lane requirements. This concept is described in a Transportation Research Board paper entitled "Wide Nodes and Narrow Roads", reprinted in Appendix D of this report.

It is important to distinguish between the modern roundabout and the traditional traffic circle. The most important operational differences are the lower speeds and "yield on entry" control used in modern roundabouts. Large traffic circles promote higher speeds. Operating speeds are lower through roundabouts due to their smaller size and the deflection (directional change) of approach roadways at entry points. A summary of features which distinguish roundabouts from traffic circles is provided in *Table 6-3*.

DISTINGUISHING FEATURES OF ROUNDABOUTS AND TRAFFIC CIRCLES

	Modern Roundabout	Traffic Circle
Control at Entry	Yield sign for entering vehicles.	Stop, signal, or give priority to entering vehicles.
Operational Characteristics	Vehicles in the roundabout have priority over the entering vehicle.	Allow weaving areas to resolve the conflicted movement.
Deflection	Use deflection to maintain low speed operation through roundabout.	Some large traffic circles provide straight path for major movement with higher speed.
Parking	No parking is allowed on the circulating roadway.	Some larger traffic circles permit parking within the circulating roadway.
Pedestrian Crossing	No pedestrian activities take place on the central island.	Some larger traffic circles provide for pedestrian crossing to, and activities on, the center island.
Turning Movement	All vehicles circulate around the central island.	Mini –traffic circles, left-turning vehicles are expected to pass to the left of the central island.
Splitter Island	Required.	Optional.

Table 6-3

Roundabouts are not a suitable form of intersection control at all locations. Where conditions are favorable, however, they can offer many advantages over traffic signal control. *Table 6-4* reviews the advantages and disadvantages of roundabouts, compared with signalized intersection designs traditionally used in the U.S.

ADVANTAGES AND DISADVANTAGES COMPARISON

Category	Advantages	Disadvantages
Safety	• There are a reduced number of conflict points compared to uncontrolled intersection. • Lower operational speeds yield fewer and less severe accidents. • Slower speeds because of intersection geometry reduce accidents.	• Since Roundabouts are unfamiliar to the average driver in the US, there is likely to be an initial period where accidents increase. • Signalized intersections can preempt control for emergency vehicles.
Capacity	• Traffic yields rather than stops, often resulting in the acceptance of smaller gaps. • For isolated intersections, roundabouts should give higher capacity/lane than signalized intersections due to the omission of lost time (red and yellow) at signalized intersections.	• Where the coordinated signal network can be used, a signalized intersection will increase the overall capacity of the network. • Signals may be preferred at intersections that periodically operated at higher than designed capacities
Delay	• Overall delay will probably be less than for an equivalent volume signalized intersection (this does not equate to a higher level of service). • During off-peak, signalized intersections with no re-timing produce unnecessary delays to stopped traffic when gaps on the other flow are available.	• Divers may not like the geometric delays which force them to divert their cars from straight paths. • When queuing develops, entering drivers tend to force into the circulating streams with shorter gaps. This may increase delays on other legs and the number of accidents.
Cost	• In general, less right-of-way is required. • Maintenance costs of signalized intersections include electricity, maintenance of loops, signal heads, controller, timing plans (roundabout maintenance includes only landscape maintenance, illumination, and occasional sign replacement). • Accident costs are low due to the low number of accidents and severity.	• Construction costs may be higher. • In some locations, roundabouts may require more illumination, increasing costs.
Pedestrians and Bicyclists	• A splitter island provides a refuge for pedestrians that will increase safety. • Low speeds reduce frequency and severity of pedestrian-vehicle accidents.	• Difficult for visually impaired pedestrians to interpret vehicle-pedestrian priority. • No stopped phase for peds who want security of a signal. • Tight Dimensions of roundabouts may create an uncomfortable feeling to bicyclists. • Longer paths increase travel distances for both pedestrians and bicyclists.

Table 6-4

Due to high traffic volumes, proximity of development, and extensive infrastructure oriented to traffic signal control, roundabouts are not considered for the three state highway intersections on 96th Street. The following factors influenced the decision to consider roundabouts at other locations within the study area:

- Traffic Volumes. Specially designed roundabouts in the UK serve as many as 8,000 entering vehicles per hour. Roundabouts are particularly well suited for volumes in the range of 3,000 to 4,000 entering vehicles per hour. Excluding state highways, 96th Street intersections currently serve 1,200 to 2,100 entering vehicles per hour. This is forecasted to increase to 2,300 to 3,600 entering vehicles per hour in 2020. This is well within the range of effective roundabout operation.

- Intersection Site Conditions. Since roundabouts require entirely different roadway approach designs and have different right of way requirements, their installation is most cost effective as an upgrade to unsignalized intersections. All 96th Street intersections between Meridian Street and Michigan Road are currently unsignalized.

- Adjacent Intersection Control. Roundabouts are ineffective where traffic signals are located in close proximity due to the potential for traffic back-ups that extend through the roundabout. Of the four intersections west of Meridian Street, this is a concern at Spring Mill Road and Shelborne, where traffic back-ups could occur at a signalized entrance from 96th Street to the proposed Duke Realty Investments development.

- Urban Setting. Between Meridian Street and Michigan Road, 96th Street passes through a vast residential area, generally extending from the edge of commercial areas along 86th Street to the northern limits of suburban growth in Hamilton County. Roundabouts offer a number of attractive features for residential settings, including traffic calming (speed control), landscape opportunities, and increased safety.

- Entrance Road Variations. Roundabouts are less sensitive than signalized intersections to skewed approaches and multiple entry points. This is an issue at Ditch Road, where the entrance to the Deerfield subdivision forms a fifth intersection leg, which is not conducive to efficient traffic signal control.

- Right of Way Constraints. At many locations, existing development along 96th Street limits the opportunity to provide additional lanes without disruptive neighborhood impacts. Roundabouts may significantly reduce the right of way required on intersection approaches. They may also reduce the need to add lanes between intersections, which would reduce neighborhood impacts even more.

Based on the considerations listed above, roundabouts are investigated in this study for potential installation at Shelborne Road, Towne Road, Ditch Road, and Spring Mill Road. Using Year 2020 traffic forecasts, capacity analyses have been conducted for these roundabouts using the SYDRA program. Developed in Australia, this program is used in several states and has been tentatively identified as the program of choice in the development of roundabout standards in the U.S. (These standards are currently in development by the Federal Highway Administration and should be available in draft form near the end of 1999.)

The capacity analyses for roundabouts at Shelborne Road, Towne Road, Ditch Road, and Spring Mill Road indicate that each intersection would operate at a level of service "B" or better during peak hours in 2020. This exceeds the level of service "D" standard of Indianapolis and the level of service "C" standard ordinarily used in Carmel/Clay Township.

For the purpose of this analysis, a 180-foot inscribed diameter roundabout is assumed at each location, with flared entries of one or two lanes according to entering traffic levels. A 30-foot center roadway is assumed in each case. The physical layouts of roundabouts investigated in this study are presented on *Figures 6-2a through 6-2d.*

It is important to note that the level of service calculations for roundabouts are based on an assumption of no interference from nearby traffic signals. Traffic back-ups from traffic signals can extend through a roundabout and block it for movement from any direction. This is not a concern at Towne Road or Ditch Road, which are located a mile from adjacent intersections, but it is a source of potential problems at Shelborne Road and Spring Mill Road, each of which is located 0.4 miles from a major state highway intersection.

As described elsewhere in this report, commercial development is planned between Shelborne Road and Michigan Road, but specific uses and access plans have not been identified in detail. Implementation of a roundabout at Shelborne Road and 96th Street should not proceed until developments and entry points on this section are known, and it has been demonstrated by engineering studies that back-ups through the roundabout will not occur.

Specific proposals have been made for commercial development between Spring Mill Road and Meridian Street, and a traffic impact analysis for the development was prepared while this study was being conducted. Signalized entry points as proposed may cause traffic back-ups through a roundabout at Spring Mill Road. As with Shelborne Road, implementation of a roundabout at Spring Mill Road and 96th Street should not proceed until developments and entry points on this section are known, and it has been demonstrated by engineering studies that back-ups through the roundabout will not occur.

96th Street Lane Requirements

This review focuses on lane requirements for 96th Street between intersections. With the concurrence of the Technical Working Group for this study, the roadway section between Shelborne Road and Michigan Road is assumed to be five lanes, consistent with nearby zoning and related studies. Multiple lanes are also assumed between Spring Mill Road and College Avenue, although the final configuration is subject to current studies and reviews of the proposed Duke Realty Investment project. Whether the remainder of the corridor should remain two lanes is a primary question to be resolved in this study.

Lane requirements between intersections are often determined by intersection approach requirements. Where successive intersections require more than one through lane in each direction to provide a satisfactory level of service, it is usually a good indication that the roadway should be four lanes. The alternative is a series of merges and diverges near intersections which are a safety hazard and are disruptive to smooth traffic flow.

Traffic forecasts for 96th Street indicate a future need for multiple through lanes at Towne Road, Ditch Road, and College Avenue. Since Towne Road is planned as a four-lane roadway in the Carmel/Clay Thoroughfare Plan, additional through lanes are not mandated on 96th Street. At Ditch Road and College Avenue, the additional lanes could be provided on either 96th Street or the cross street.

Another measure commonly used to gage the need for added lanes is average daily traffic. The capacity of a two-lane roadway is dependent on a number of factors, including the geometric design of the roadway, the number of entries or conflict points, the ability to separate turning movements from through movements, and traffic distribution throughout the day. Typically, two-lane roadways begin to exhibit stress when average daily traffic levels exceed 16,000 to 20,000 vehicles per day.

96TH STREET & SHELBORNE ROAD
ROUNDABOUT INTERSECTION IMPROVEMENT

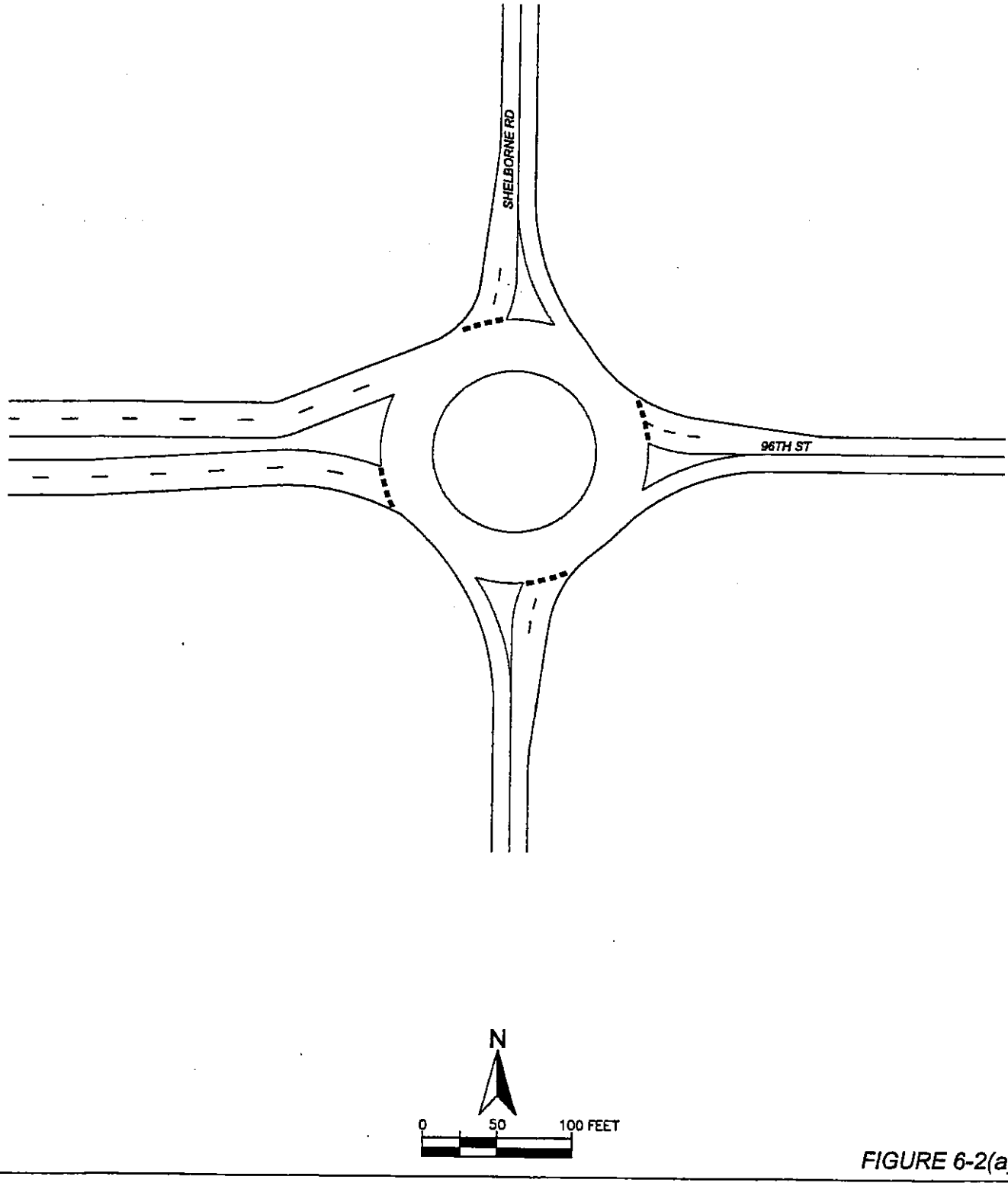
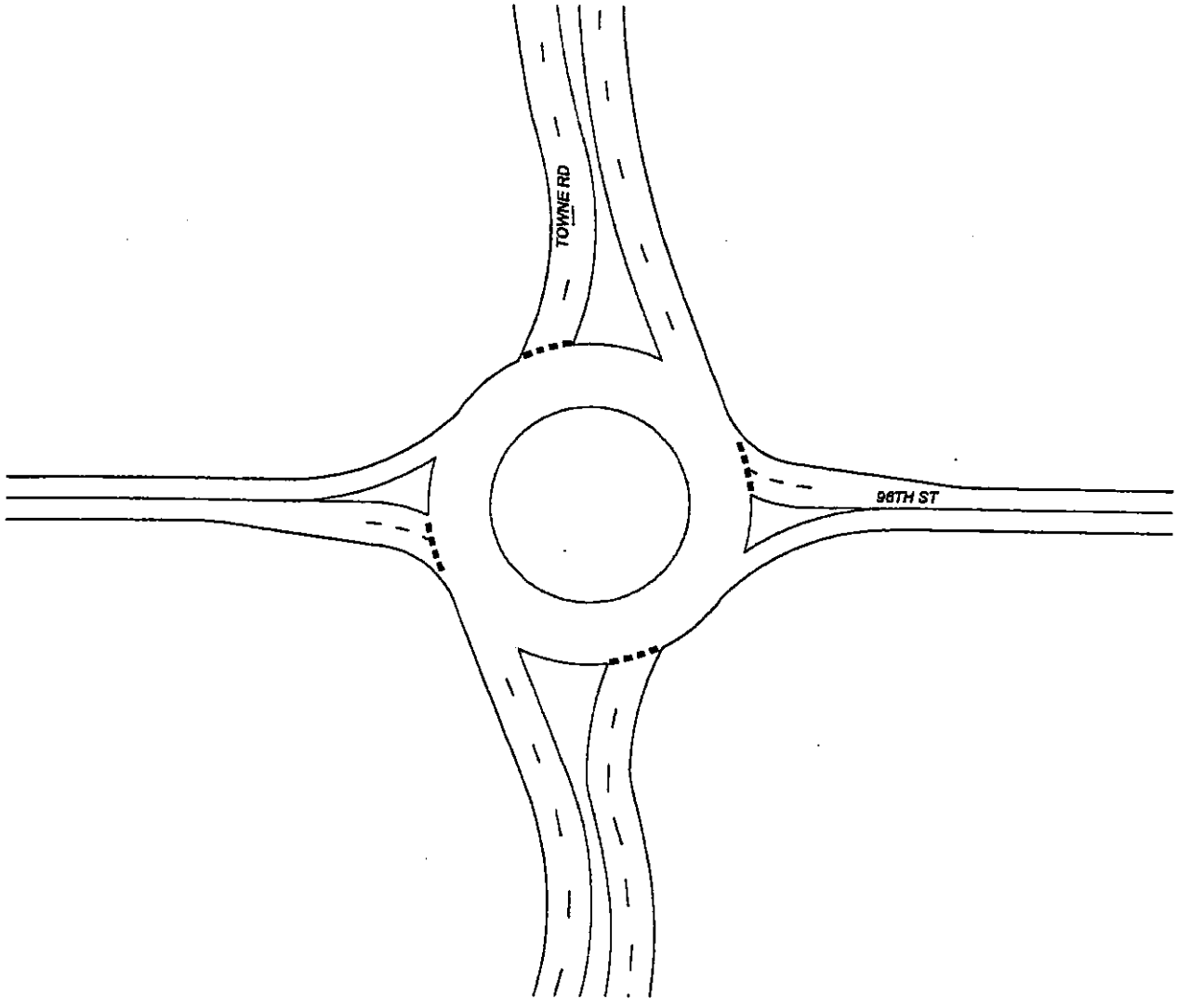


FIGURE 6-2(a)

96TH STREET & TOWNE ROAD
ROUNDABOUT INTERSECTION IMPROVEMENT



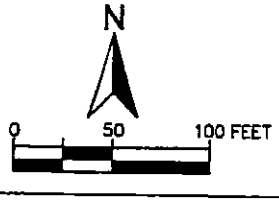


FIGURE 6-2(b)

96TH STREET & DITCH ROAD
ROUNDABOUT INTERSECTION IMPROVEMENT

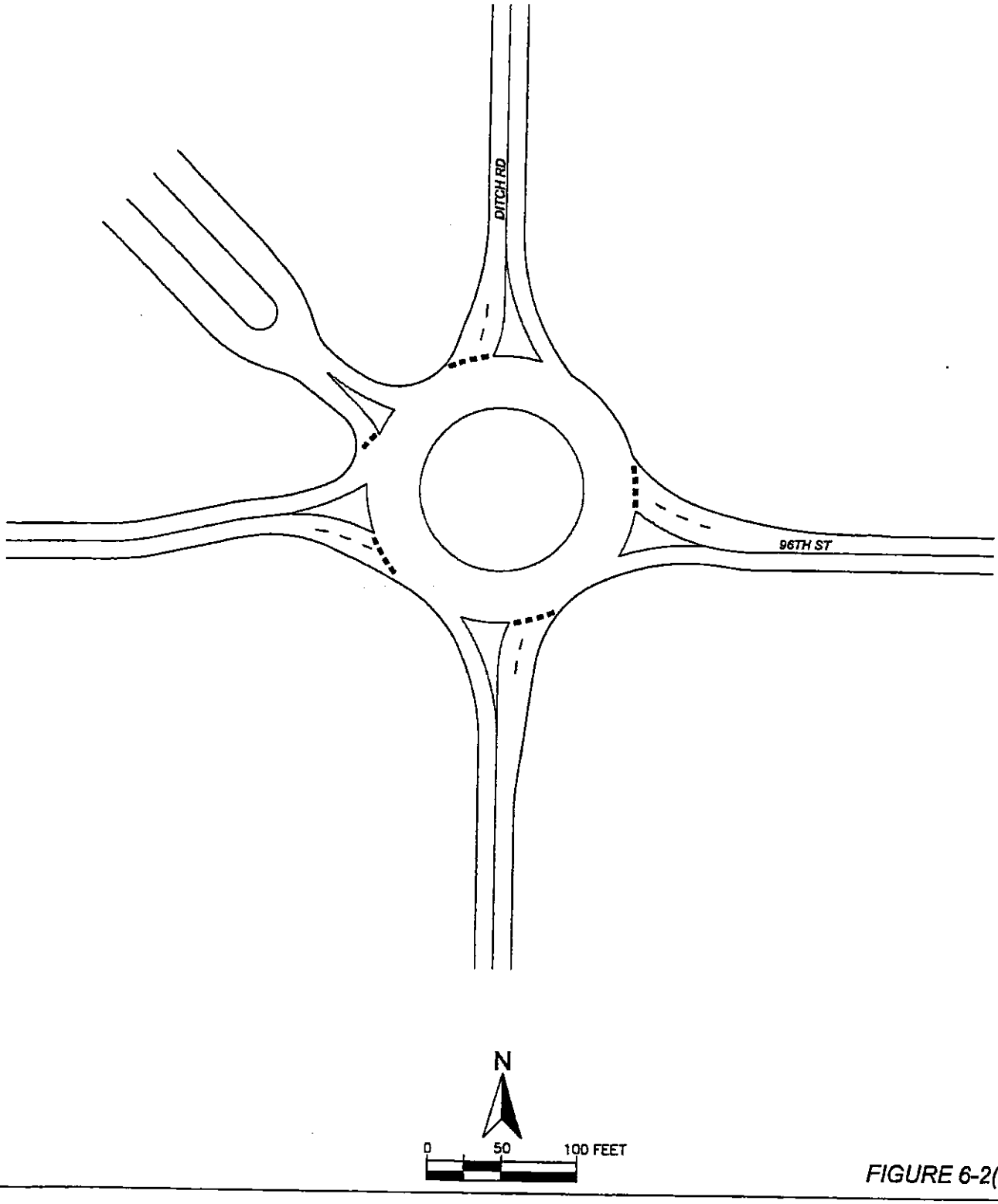
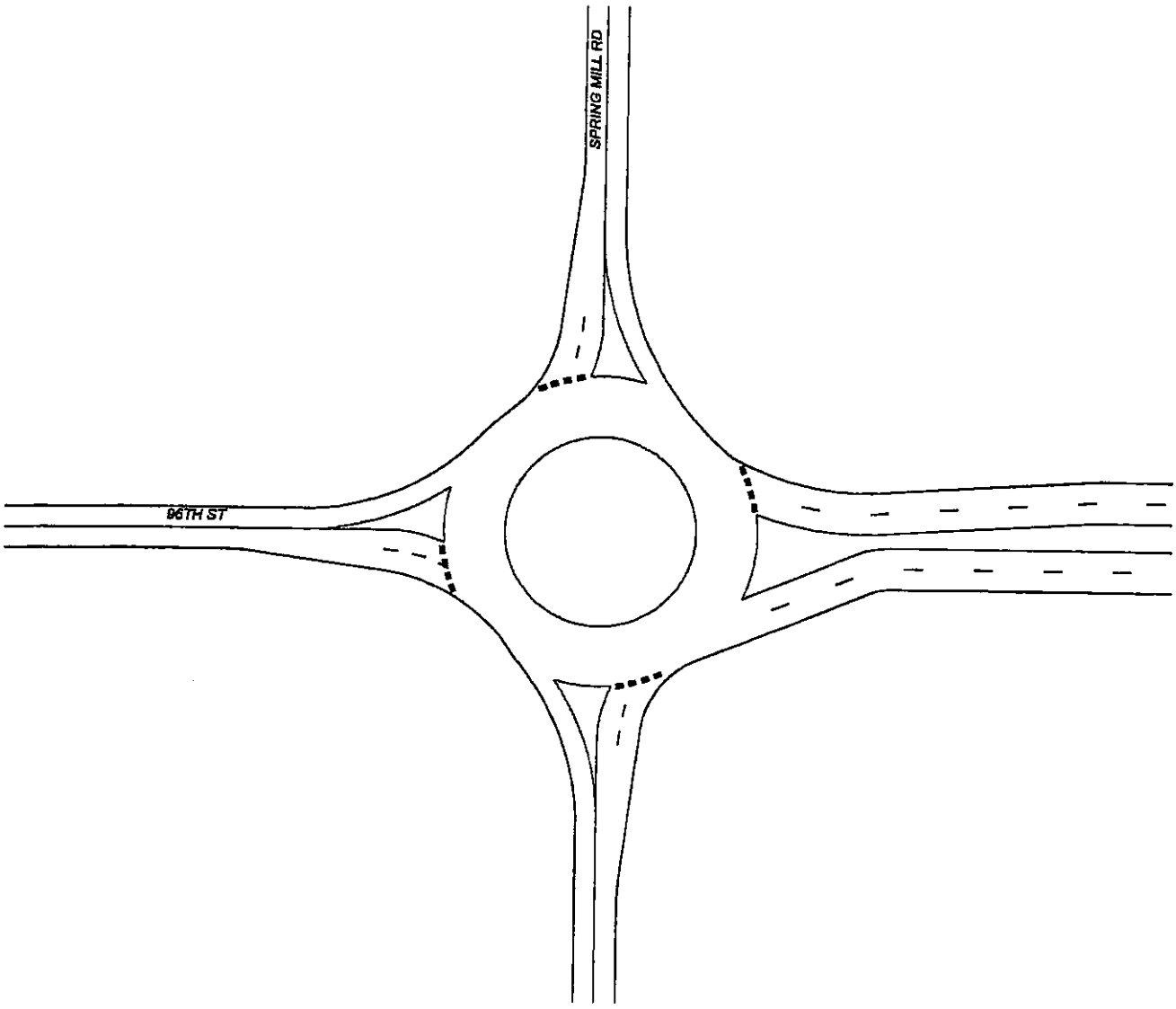


FIGURE 6-2(c)

96TH STREET & SPRING MILL ROAD
ROUNDABOUT INTERSECTION IMPROVEMENT



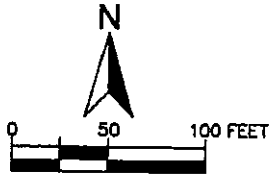


FIGURE 6-2(d)

Neglecting sections of 96th Street already planned for multiple lanes (between Meridian Street and College Avenue, and west of Shelborne Road), average daily traffic forecasts for this corridor range between 9,500 and 21,300 vehicles per day. Clearly, this puts 96th Street at the threshold of requiring four lanes, but it does not establish an absolute need. First of all, there is a range of error in forecasting, particularly where alternate routes are available. As traffic levels approach 20,000 vehicles per day, some motorists would seek alternate routes, and the higher forecast may never be achieved. Secondly, there are several examples of two-lane roadways which currently serve traffic volumes this high. A sample of these roadways is provided in *Table 6-5*.

HIGH VOLUME TWO-LANE ROADWAYS IN THE INDIANAPOLIS REGION

Roadway	Volume
Kessler Boulevard Between Fox Hill & Spring Mill	20,394
Georgetown Road Lafayette to 56th Street	20,666
Allisonville Road at 116th Street	21,418
Michigan Road at Boone Co. Line	23,908

Table 6-5

An additional reason for adding travel lanes is to serve a larger network capacity need identified as a part of regional long range planning. As described in the chapter on traffic forecasting, the Indianapolis travel simulation model indicates that the location of the 96th Street corridor is conducive to drawing traffic from parallel routes. Nevertheless, regional planning studies to date have not identified a need for this relief.

Overall, there are indications that traffic operations on 96th Street would be better served with the addition of added travel lanes and that traffic volumes would be reduced on parallel roadways within the larger roadway network. Neither of these benefits make it essential to widen the roadway, however. The issue of widening 96th Street must be weighed against neighborhood impacts and cost.

96th Street Roadway Alternatives

Four roadway options were identified for review within the two-lane sections of 96th Street. With some minor exceptions (due to differing standards), right of way for these options is based on standards in effect for Indianapolis, Carmel, and Hamilton County. Typical cross sections and associated right of way standards are shown on *Figure 6-3*. These four roadway options are described below:

Two-Lane Typical Section – The roadway could continue to provide two through lanes of travel, supplemented by auxiliary lanes at intersections. This alternative assumes that left turn conflicts at major drives are accommodated by left turn lanes or passing blisters. Right of way requirements could vary at intersections. The suggested right of way is consistent with local standards and would provide sufficient space for utilities and non-motorized travel facilities (sidewalks/trails).

Three-Lane Typical Section – A three-lane roadway increases the utility of the two through lanes by eliminating left-turning vehicles from the vehicle stream. This option is efficient where there are large numbers of left turns or where drives and intersection approaches are so numerous that ordinary left turn lanes "run into" each other. Assuming that right turns are addressed by proper tapers to drives, a three-lane road maximizes the capacity of the two through lanes. In some cases (such as on 96th Street between Meridian Street and College Avenue), a three lane section is conducive to serving localized traffic needs within a larger two-lane corridor.

Four-Lane Typical Section – This option provides four lanes for through travel, supplemented (as with the two-lane section) with auxiliary lanes at intersections, and turn lanes at major drives and approaches between intersections. The right of way shown includes provision for utilities and non-motorized travel. Additional right of way may be needed at intersections.

Four-Lane Boulevard or Five-Lane Typical Section – This option includes a 16-foot center median to provide a more aesthetically pleasing roadway and to accommodate left turn lanes. In some areas, the center left turn lane may become continuous, creating a five-lane section. In either case, the right of way shown is sufficient to accommodate utilities and non-motorized travel. The need for additional right of way at intersections is lessened under this alternative.

As a companion to this report, a set of full size aerial photographic overlays has been developed to illustrate the potential right of way impacts of the roadway alternatives described above. These drawings were displayed for review and comment at the public forum held to discuss this project on September 1, 1999.

Residential Parkway Concepts

In recent years, Carmel has been successful in implementing residential parkway concepts within selected roadway corridors. Key elements are grassed or landscaped medians, landscaped borders, multi-use paths, and special roadway design features. Some residential parkways have two-lane sections (one in each direction), with auxiliary lanes at selected locations to serve turning traffic. Examples are River Avenue north of 131st Street and Hazeldell Avenue north of 131st Street. These roadways link effectively with roundabouts at 131st Street.

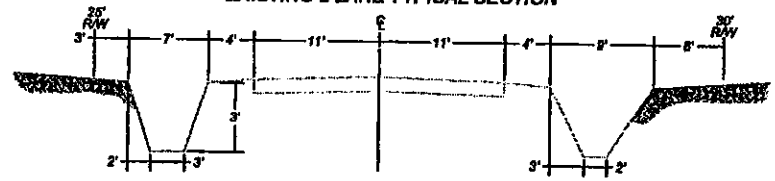
Parkway options are attractive for the 96th Street corridor due to the predominance of residential use between major intersections. When properly designed, these techniques can provide for the safe and efficient flow of traffic while providing amenities and traffic calming elements suitable for a residential neighborhood setting.

Applying residential parkway concepts on 96th Street will require detailed design studies. Some sections (such as near the cemetery west of the I-465 bridge and east of Ditch Road) are too narrow for median construction. In other areas, access to both sides may require a dual center left turn lane. Most importantly, traffic volumes are projected to be significantly higher on 96th Street than on the residential parkways currently existing in Carmel. Wide lanes on a two-lane boulevard may result in improper and unsafe passing maneuvers under high volume conditions.

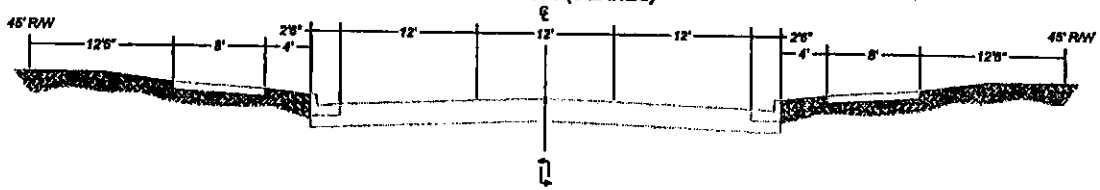
Residential parkway concepts offer significant promise for design within the corridor, but they should not be adopted until a detailed design study has been completed. The design study should identify site-specific opportunities and constraints, review traffic impacts of options, and set specific pavement and right of way lines for implementation.

ROADWAY TYPICAL SECTIONS

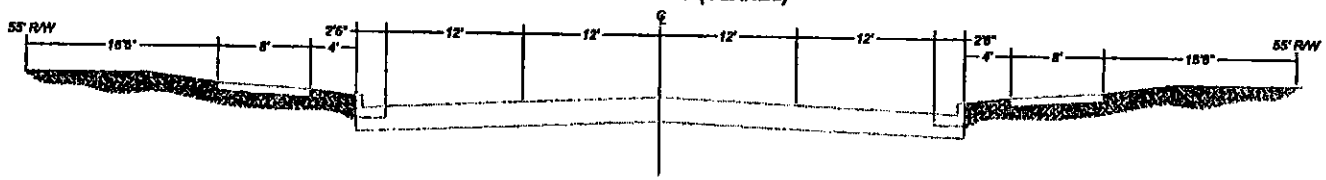
EXISTING 2-LANE TYPICAL SECTION



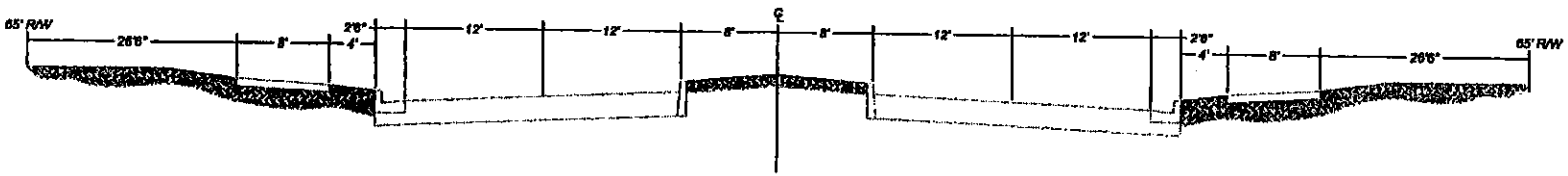
ALTERNATIVE 1 (3 LANES)



ALTERNATIVE 2 (4 LANES)



ALTERNATIVE 3 (4 LANES + BOULEVARD, PROTECTED LEFT TURNS)



NOT TO SCALE

FIGURE 6-3

7. ALTERNATIVES REVIEW & RECOMMENDATIONS

Chapters 1 through 6 described the character and context of the 96th Street corridor, identified current and future traffic needs, and reviewed alternative approaches to meeting these needs through roadway and intersection improvements. This information was presented and discussed with the Technical Working Group in a series of meetings held between January and August 1999. It was also presented at public forums on February 23, 1999 and September 1, 1999, and a significant amount of public input was received in oral and written form.

This chapter summarizes the key findings of the study process based on the technical studies, committee discussions, and public input described above. Based on these findings, the Technical Working Group developed a set of study recommendations as presented in this chapter. **These recommendations should not be considered final decisions. They are proposed to government leaders to be acted upon at their discretion.**

STUDY FINDINGS

A great deal was learned about the 96th Street corridor through the course of this study. The most pertinent information related to alternatives evaluation is summarized here in the form of general study findings. These findings form the basis for study recommendations.

Urban Setting/Land Use

1. 96th Street is residential in nature from Michigan Road to Keystone Avenue, except for commercial nodes near major crossroads served by I-465 interchanges.

2. Because of the predominance of residential development, there are quality of life issues in addition to traffic movement issues that are significant in this corridor.

3. Comprehensive Plans recommend preserving existing neighborhoods by allowing and providing for non-residential development only within designated areas at existing commercial nodes.

4. Traffic forecasts for alternate growth scenarios indicate that vacant properties can be developed within existing residential zoning categories with minimal effect on future 96th Street lane requirements.

5. Public comments indicate strong community interest in retaining the residential land uses and neighborhood character of the area as transportation improvement alternatives are evaluated.

Transportation Setting

1. In Marion County, 96th Street is classified as a secondary arterial within the study area. Functional classifications in Carmel/Clay and Hamilton County Thoroughfare Plans vary according to location within the corridor. Both classify 96th Street as a primary arterial near U.S. 31, and a secondary arterial or collector on other sections.

2. 96th Street functions as an important component of a larger regional thoroughfare system. Parallel routes include 86th Street, 106th Street, and 116th Street. I-465 is also located closely parallel to 96th Street within this corridor.

3. 96th Street differs from other parallel routes due to its location next to I-465. Both routes are part of the regional traffic grid, with longer regional trips tending to use I-465.

4. I-465 interchanges at Michigan Road, Meridian Street and Keystone Avenue significantly influence development patterns, traffic demand, and traffic congestion at nearby 96th Street intersections.

5. Insufficient capacity in the vicinity of I-465 interchanges could affect traffic demand on 96th Street as motorists seek other routes to avoid congestion. The findings and recommendations of this study are subject to review and adjustment if development proposals or I-465 access differ significantly from assumptions documented here.

6. The role of 96th Street in the overall system would change if a substantial increase in capacity were provided by widening it to four lanes. Traffic simulations used to evaluate induced traffic effects indicate the corridor would draw 50% to 100% more traffic with four lanes as compared to two lanes.

Roadway Segments

1. To accommodate localized traffic demand in commercial areas, 96th Street will require widening between Michigan Road and Shelborne Road, and between Spring Mill Road and College Avenue.

2. Accommodating forecasted traffic levels outside commercial areas with a two-lane roadway is feasible if the roadway is designed properly, including auxiliary lanes as necessary at intersections and major entry points.

3. If two lanes are retained, Year 2020 forecasts indicate that 96th Street would be congested during some periods, but would be manageable, similar to existing conditions on two-lane sections of Allisonville Road in Marion and Hamilton Counties and Westfield Boulevard in Marion County.

4. Public input indicates that a large majority of residents in neighborhoods served by 96th Street would oppose the widening of 96th Street to four lanes outside existing commercial areas.

Intersections

1. Traffic forecasts support the need to improve all intersections within the corridor, particularly those currently controlled by four-way stop signs.

2. Current traffic counts at 96th Street and Westfield Boulevard do not indicate greater traffic diversion than previously expected as a result of the new 96th Street bridge over White River. The findings and recommendations of the 1997 study of this location remain valid.

3. Either traffic signals or modern roundabouts could be used to meet future intersection control needs within the corridor.

4. If signalization were the selected option, stop controlled intersections would require roadway widening in each direction to provide at least two lanes on all approaches (including a separate left turn lane). Towne, Ditch, Spring Mill, and College indicate the need for additional lanes through the intersection with traffic signal control.

5. As an alternative to traffic signal control, roundabouts would reduce lane requirements on approaches. Other potential advantages include the following:
   -improved traffic flow during non-peak periods
   -compatible with two-lane or four-lane roadway designs
   -opportunity for aesthetic treatments compatible with the residential setting
   -opportunity for a distinctive statement at the Marion/Hamilton County line
   -less expensive to install and maintain than signalized intersections.

6. Roundabouts would provide adequate capacity to serve year 2020 demand at Shelborne Road, Towne Road, Ditch Road, and Spring Mill Road.

7. A roundabout at Towne Road would accommodate multi-lane approaches from any direction.

8. A roundabout at Ditch Road would accommodate the "fifth" leg and retain the entry gate to Deerfield subdivision.

9. Roundabouts at Shelborne Road and Spring Mill Road would provide a transition between the multi-lane commercial areas near Michigan Road and Meridian Street and the residential (two-lane) areas to the west and east, respectively.

10. Engineering studies would be required in siting any signalized drives or intersections close to roundabouts since back-ups from adjacent traffic signals can block traffic flow through roundabouts.

11. Public input indicates strong interest and a high likelihood of acceptance of roundabouts in the corridor.

STUDY RECOMMENDATIONS

Study recommendations were developed in a series of meetings of the Technical Working Group during September and October, 1999. They reflect general consensus of a wide range of agencies and interest groups (see listing, Chapter 1) and are consistent with public input and the study findings listed above. **These recommendations should be given primary consideration by affected agencies when making land use and transportation decisions along the 96th Street corridor.**

Recommendations are shown in italics to clearly distinguish them from findings, presented previously in this chapter.

Overall Corridor

1. *Since 86th Street and 116th Street are primary arterials, and since I-465 is intended to serve longer distance travel, these routes should be the focus in addressing long-term regional travel needs.*

2. *Any improvements to 96th Street should be designed to minimize right of way impacts, support residential neighborhoods, and enhance the overall residential character of the corridor.*

3. *Where feasible, consideration should be given to residential parkway techniques that provide for the safe and efficient flow of traffic while providing amenities and traffic calming elements suitable for a residential neighborhood setting.*

4. *Where feasible, improvements along the corridor should incorporate multi-use paths. A special effort should be made to connect the Monon trail to multi-use paths at Michigan Road.*

5. *Trade-offs between parkway elements (medians, paths, landscaping, etc.) and adjacent property impacts are site-specific and should be determined in a detailed corridor design study.*

6. *Adjoining jurisdictions should continue to cooperate and coordinate when making land use and transportation decisions that affect the 96th Street corridor, as suggested in Chapter 8.*

Land Use

1. *Commercial development should be limited to areas already planned and/or currently zoned for this use.*

2. *Development proposals for commercial areas should be accompanied by traffic plans which minimize impacts on 96th Street by providing suitable access to adjacent arterial roadways, including I-465 interchanges.*

3. *Decisions regarding development proposals for vacant parcels in residential areas should be based on the character of surrounding property and other community-based issues including site specific traffic impacts.*

Intersections

1. *Subject to final engineering, roundabouts should receive primary consideration for design and implementation at Spring Mill Road, Ditch Road, Towne Road, and Shelborne Road. Since improvements are already warranted, these engineering studies should commence as soon as feasible.*

2. *Engineering studies should consider and address potential back-ups from proposed/potential signalized intersections or entry-points to insure that traffic will not back up through the roundabout. Roundabouts should be constructed only if these engineering studies show that blockages of roundabouts will not occur.*

3. *The 96th Street/Meridian Street intersection should be improved to accommodate localized commercial traffic in a manner that does not encourage development traffic in residential areas.*

4. *A right turn lane on the northbound approach to the 96th Street/Westfield Boulevard intersection would significantly reduce congestion. An engineering study should be*

done to evaluate its cost, and it should be considered in any upgrade or modification to the existing Westfield Boulevard bridge over I-465.

Roadways

1. *96th Street should be widened to four through lanes with center left turn lanes (or five lanes) between Michigan Road and Shelborne Road. Traffic and access control details should be determined in site-specific traffic studies.*

2. *A corridor should be preserved for an extension of 96th Street west of Westfield Boulevard on a slightly skewed alignment over I-465, should this connection be needed in the future.*

3. *96th Street should be upgraded to an improved two-lane roadway between Shelborne and Spring Mill, between College and Real Street, and between Westfield Boulevard and Haverstick. The improved roadway should provide adequate intersection treatments, standard lane widths, and auxiliary lanes at major entry points.*

4. *Where possible, right of way required for widening should be taken from undeveloped land to minimize impact on existing residential development. If there are vacancies or similar developments on both sides, equal amounts from the centerline should be taken.*

5. *As development and land use changes occur, right of way should be dedicated consistent with a functional classification of secondary arterial or higher, depending on location. Right of way from property already developed should not be taken until the need is specifically identified in a corridor design study.*

6. *A corridor design study should be undertaken to identify proposed center lines, pavement areas, and right of way needs for the proposed two-lane roadway. The study should consider multi-use paths, parkway concepts, and other aesthetic and traffic calming enhancements consistent with the character of a residential corridor.*

7. *Although four lanes are not recommended during the planning period of this project, the corridor design study recommended above in number 6, should evaluate potential long-term right of way impacts beyond two lanes so that options might be retained in the future.*

8. IMPLEMENTATION ISSUES

This study has achieved its purpose in developing technical information, presenting it to public agencies and citizens, and arriving at a recommended future configuration for 96th Street. It is hoped that this study will be useful to elected officials, planning agencies and others as they influence future growth and development in the corridor. The ultimate objective, however, is implementation of the recommendations.

It is unlikely that all improvements would be implemented at the same time. In fact, these study recommendations lend themselves well to staged construction over time. This chapter reviews implementation issues related to construction staging and sequencing, and provides preliminary cost estimates for use in programming projects.

Staging and Sequencing

Within this study corridor, traffic conditions and land use are most intense near the three major crossing roadways (Michigan Road, Meridian Street, Keystone Avenue), due largely to the influence of nearby interchanges with I-465. These nodes function independently, and traffic congestion and associated roadway needs are localized. Between these commercial nodes, 96th Street is a residential corridor, with a different set of land use conditions and lower traffic volumes.

These conditions result in a number of options for staging the recommended improvements, ranging from intersection modifications to added travel lanes on selected roadway segments. A logical sequence of construction would be one which responds to evolving needs within the corridor.

The following staging and sequencing plan is suggested, based on conditions at the time of this study:

Recommended near term actions:

1. Roundabout Design and Construction (Shelborne to Spring Mill) – Engineering studies should be initiated as soon as feasible, since need is already established. Design and construction can be one at a time or simultaneous. Likely to be local government funded, possibly with federal-aid.
2. Roadway Design and Construction (Michigan to Shelborne) – Within the next two years to coincide with INDOT Michigan Road improvements. Likely to be local government funded, possibly with federal-aid.
3. Corridor Design Study (Shelborne to Spring Mill; College to Haverstick) – Conducting this study soon would provide more specific information for citizens, provide for adequate construction and/or right of way dedication to serve new development, and allow for more detailed and reliable cost estimating.
4. Westfield Boulevard Bridge Study – A review should be conducted to evaluate the methods and cost of modifying the existing bridge over I-465 to provide a northbound right turn lane at 96th Street (E).

Actions in response to development:

1. Meridian/96th intersection – Timing and need determined by Traffic Impact Study results and Plan Commission review; need is dependent on development. May include private, state, and/or local funding.

2. Roadway expansion (Spring Mill to College) – Timing and need determined by Traffic Impact Study results and Plan Commission review; need is dependent on development. May include private, state, and/or local funding.

Actions in response to traffic demand and funding opportunities:

1. Roadway reconstruction (Shelborne to Spring Mill; College to Haverstick) – Safety and aesthetics might benefit by early construction, but traffic conditions do not indicate a need for immediate reconstruction of 96th. Construction should proceed when needed to serve traffic demand.
2. Intersection improvements (College/96th, Real/Westfield, Westfield/96th) – These intersections should be upgraded as needs dictate and funding allows.
3. 96th Street bridge over I-465 at Westfield – A corridor should remain clear for ultimate construction of this bridge if needed. Timing of construction (if it occurs) should be based on need as indicated by traffic demand.

Implementation Cost

A preliminary estimate of cost for proposed changes to the 96th Street corridor is in the range of $15-million to $20-million. This estimate is based on costs for similar projects implemented in the Indianapolis region, and its level of accuracy is consistent with the detail of recommendations provided by this study. Greater precision can only be provided based on more site specific studies, as described below:

1. This report identifies generalized concepts for 96th Street. As indicated in this report, more detailed corridor studies are needed to incorporate residential parkway concepts and to identify final site specific right of way requirements.

2. As indicated in the findings and recommendations in Chapter 7, actual roadway configurations near Michigan Road, Keystone Avenue, and Meridian Street should be determined based on specific development proposals. Costs and implementation plans should be determined in traffic impact analyses for these projects.

3. Although roundabouts have been recommended for primary consideration at several locations, their feasibility and final layouts are subject to engineering studies being initiated by Hamilton County. These studies will provide site specific detail for roundabout implementation based on field surveys of the proposed intersections.

As stated previously, it is most likely that the recommendations of this study will be implemented through a number of independent projects. The estimated costs for these projects should be determined when concepts are defined in greater detail.

Multi-jurisdictional Issues

This study has benefited from the direct involvement of all agencies that have a direct jurisdictional interest in the corridor. Hamilton County, Carmel and Indianapolis DCAM share responsibility for 96th Street and its approaching roadways. Indianapolis Department of Metropolitan Development has planning and zoning responsibility on the south side of the street. INDOT controls the 96th street intersections with Michigan Road, Meridian Street, and Keystone Avenue; and nearby I-465 interchanges have a significant impact on traffic patterns throughout the corridor.

The seamless character of the transportation system makes the need for cooperation obvious. Transportation facilities must function as an integrated system to be effective. Consistent roadway and right of way standards might be desirable, but are not likely given the differing needs within each jurisdiction. In the absence of that, cooperation is especially important in providing plans and facilities that make sense.

One means of accomplishing this cooperation is through joint planning studies such as this one. Another approach is to share designs and plans so that others may offer comments or adjust the facilities within their jurisdiction. A third approach is to work with the Metropolitan Planning Organization to identify common planning objectives and standards for facilities with multi-jurisdictional significance.

Perhaps the most important area for cooperation is in the area of land use and zoning approvals. Clearly, each jurisdiction must retain its autonomy to be effective in advancing local community goals, but some level of formal comment would be desirable. Each planning agency has a process in place for review by a technical advisory committee (TAC). As a minimum, adjacent jurisdictions should be given the opportunity to review proposals at the appropriate time and provide direct input to the TAC. This was agreed to at the first meeting of the oversight committee for this study. The process should be formalized and routinely implemented.

The success of this study in guiding multiple involved agencies toward a common vision for 96th Street will be determined by what is actually constructed in the corridor. The public would benefit directly from a continuation of this cooperative approach as concepts are defined in greater detail, and the recommendations are implemented.

Appendix A: PUBLIC MEETINGS

96th Street Corridor – Michigan Rd. to Keystone Av.
Public Meeting
Nora Public Library

AGENDA
February 23, 1999
7:00 pm – 9:00 pm

1) Introductions Steve Cunningham	(5 min)
2) Project Overview Tom Bartlett Sharon Clark Mike Hollibaugh	(10 min)
3) Work Scope and Schedule Review John Myers	(5 min)
4) Transportation – Existing Conditions Transportation – Existing Service Levels Transportation – Committed Projects John Myers	(10 min)
5) Land Use – Existing Conditions Land Use – Committed Projects Land Use – Current Planning & Zoning John Myers	(10 min)
6) Public Comment (Issues, Opportunities, Concerns)	(60 min)
7) Wrap-up/Upcoming Meetings Steve Cunningham	(5 min)

Public Meeting
Nora Public Library
Tuesday February 23, 1999
Attendance: 45

Speakers:
Sharon Clark/Hamilton Co. Commissioner, Steve Cunningham/DMD, Tom Bartlett/DMD, Mike Hollibaugh/Carmel Planning, John Myers/PB

SC – Main reason for public meeting is to inform the general public about the study and give them an open forum to discuss issues.

TB – Need is to work together to make the corridor serve both sides of the street.

Questions/Comments:

- Are we still considering the bridge connecting 96th St.?
- Since most of the new development is north of 96th St. (Hamilton Co.), why not concentrate on 106th St. or 116th St. for widening. Concentrate on the north-south streets.
- Does two-lane include a middle turning lane?
- Deerfield residents are concerned about access to their neighborhood if the intersection is reconfigured.
- Worried that inevitably commercial/retail will be drawn to 96th St. and it will become just like 86th St. Is there a way to make 96th St. so that it is not conducive to commercial growth? Raised medians, less curb cuts, etc.
- We should take a look at the study they did for 146th St. It uses a wide parkway type street. It also considers the use of bike paths.
- Any possibility for an interchange at I-465/Towne Rd.?
- Would hate to see 96th St. become like 86th St. What are the plans for the vacant areas? What goes in these areas could determine if 96th St. stays 2 or 4 lane.
- Any plans for a full cloverleaf interchange for I-465/Meridian St.?
- Median issue. There was enough right-of-way to do this on 86th St., but on 96th St. there are to many homes that are too close to the street already.
- Does the study done of 96th St./Westfield area have to be reexamined since the opening of the White River bridge?
- A resident of 96th St./Maple St. has noticed a change (increase) in traffic since the opening of the White River bridge.
- If anything is done to 96th St., please consider bicycles.
- Where is all the traffic that will be generated by new developments to the north (Village of West Clay, Westfield) going to go?

- Can the state condemn the land around the I-465/Meridian interchange?
- Planners should look at the preservation of neighborhoods. They need to look at ways to better them and not destroy them.
- Is growth going to be controlled so that fast-food restaurants and the like will not appear unchecked?
- What about the use of round a bouts?
- Sharon asked the crowd how they heard of this meeting (most through neighborhood newsletters) and asked for suggestions on how to better get the word out. Meeting was then adjourned.

MEMORANDUM

TO: John Myers

FROM: Steve Cunningham

DATE: March 1, 1999

RE: Comments from February 23rd 96th Street Study Public Meeting

Main comments and issues are as follows:

- There was discussion of the possibility of a bridge over I-465 on 96th Street west of Westfield Blvd. Are there any plans? Majority seem opposed to such an idea.

- Why should the focus be on 96th Street? Need to take traffic to 116th Street and deal with it on that facility. Encourage traffic to use other east-west options.

- The residents of Deerfield are concerned that any improvements at 96th and Ditch consider their need for safe and efficient ingress and egress. Currently their entrance comes into the intersection at an angle.

- Assuming 96th Street becomes four lanes (some sentiment that it is an eventuality) it is obvious that retail development will be attracted to the corridor. Can we design a corridor that will discourage retail development with bike paths, parkways, etc...? Public is skeptical of their influence on the zoning process and need to look for other mechanisms to address the development of commercial. Medians do discourage commercial development. But right-of-way on 96th is limited.

- 146th Street should be considered in this study as it influances 96th Street. Specifically the study that has been done for 146th Street and its recommendations.

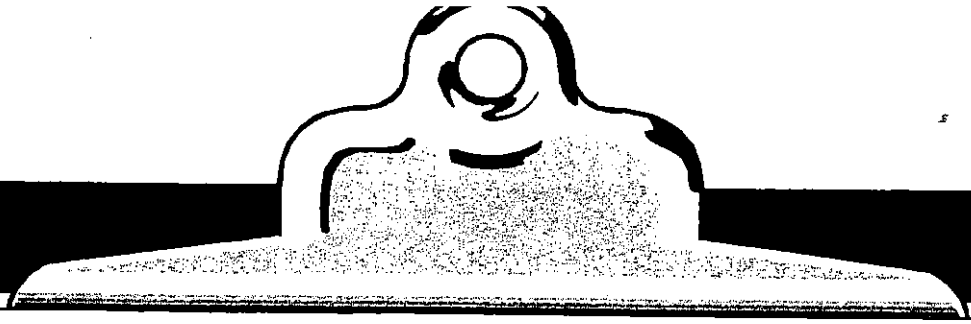
- Do not want 96th Street to become a four lane road and another 86th Street.

- What has been the impact from the opening of the 96th Street bridge? Should re-evaluate as recommended in the special study of 96th/Westfield.

- Bicycle lanes, shoulders and paths should be considered in any plans for 96th Street.

- Traffic conditions on 96th Street in short after development (West Clay) and before improvements. This will impact 96th and will cause cut-through traffic.

- Neighborhood preservation should be given higher priority than the movement of traffic.



96th Street Corridor Study
Michigan Rd. to Keystone Av.
Public Meeting
Clay Township Community Center

AGENDA
September 1, 1999
7:00 pm – 9:00 pm

1) Introductions *Steve Cunningham*	**(5 min)**
2) Project Overview, Work Scope, Schedule Review *Steve Cunningham*	**(5 min)**
3) Land Use - Existing Conditions, Growth Scenarios *John Myers*	**(15 min)**
4) Transportation – Existing Conditions, Traffic Projections, Future Conditions *John Myers*	**(15 min)**
5) Alternatives – Roadway Sections, Intersections *John Myers*	**(20 min)**
6) Break	**(15 min)**
7) Public Comment **(questions, concerns, opportunities)**	**(45 min)**
8) Wrap-up/Next Steps *Steve Cunningham*	**(5 min)**

- Something needs to be done now at the intersections.
- Is there going to be an expediential effect on 96th St. that result from any improvements? Does the study address this?
- Have you looked at "If you build it they will come?" scenario?
- I find it very interesting that there is no representative from the Hamilton Co. Hwy Dept. Why is it that Indianapolis always tells Hamilton Co. what to do concerning issues on 96th St.?
- Nobody has mailed me anything about this study. How can we stay informed?
- If it is determined that 96th St. will be widened, how expensive and inconvenient will it be?
- It seems like the roundabouts are the best solution.
- PR – the study is not aimed at putting more asphalt down.
- Is there any historical precedent that the capacity of the roadway limits the land use?
- If they close Spring Mill Rd., what will you do at 96th St.?
- As a resident of 110th St./Westfield, I have noticed a tremendous change in traffic volumes since the White River bridge has gone in.
- How does the RoW affect properties?
- People along Spring Mill don't want it closed, they just want something done and done right.
- Who would pay for any property compensation?

MEMORANDUM

TO: John Myers, Parson Brinckerhoff

FROM: Steve Cunningham, Indianapolis MPO

DATE: September 14th, 1999

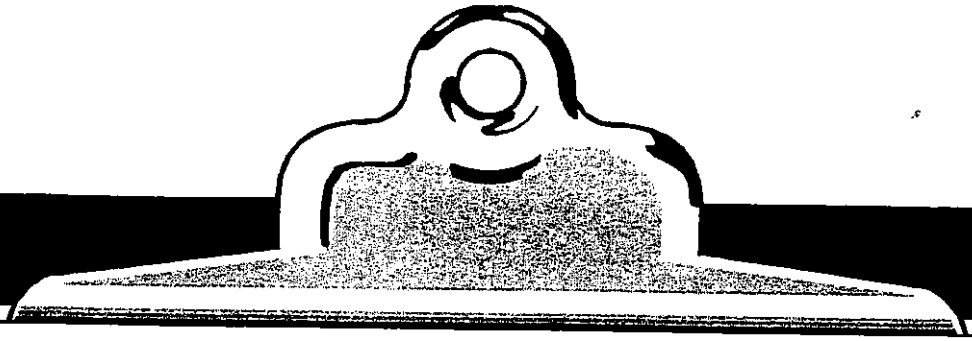
RE: Public comments from September 1st meeting

Unlike the majority of comments received at the February public meeting, which were primarily concerns and issues, the comments received on September 1st were questions and comments specific to the alternatives presented. Following is a summary of the comments received in writing after the meeting, since Dan Lake has already summarized the comments from the meeting itself.

1. The best answer to the congestion west of Shelborne is widening to 4 or 5 lanes. Modern roundabouts will help solve problems at Township Line Road and Ditch Road. Once people learn to use them it will alleviate a lot of frustration. Widening the corridor to 4 or 5 lane boulevard is an invasion of homeowner rights and is not a valid solution.
2. My major concerns are increased vehicular traffic, loss of privacy, increase in noise and exhaust, and property values.
3. I am concerned about making a residential street into a racetrack.
4. I support the use of roundabouts at Ditch, Towne and Shelborne as an attractive and cost effective way to gain additional capacity with the least disruption to the neighborhood.
5. I am familiar with roundabouts elsewhere and believe the configurations presented are underestimated. I support roundabouts because they eliminate gridlock and key intersections, least intrusive on existing properties, least inviting to large commercial development, eliminates need to relocate utilities, and potentially least expensive.
6. I strongly oppose widening of 96th Street because it ruin homes, only the intersection are insufficient and if it is widened, more cars will come. If roundabouts would save us from 4 lanes, I would support them. Would need carefully designed education campaign.
7. I live at 96th and Spring Mill and make an urgent plea not to widen 96th Street to a 4-lane road. It will soon be like busy 86th Street, destroying good part of our neighborhood, reducing property values and adding noise pollution. Roundabouts are acceptable if necessary.
8. Why encourage additional traffic by building a wider road which would be extremely detrimental to our residential neighborhood.
9. What alternatives could be developed which would move traffic from 96th to other higher capacity routes? What types of lane use could be permitted for vacant parcels which would allow development but limit traffic pressures? Simple methods of

blocking selected streets could be used to limit traffic in the area and move it to higher capacity roads.

10. If 96th Street is widened to 5 lanes between Michigan and Shelborne, I would be concerned about a cut in the median to accommodate access to our business. We are familiar with roundabouts and find them very efficient and attractive. They would work well with the type of traffic on 96th (low during the day and high at rush hour).
11. A 96th Street pedestrian-bikeway component would feed a lot of non-motorized traffic to and from the Monon Trail.
12. We believe roundabouts are wonderful and we encourage them everywhere possible.
13. Could roundabouts be used at the exits from the proposed Duke property and at Spring Mill Road?
14. There will be an increase in traffic with what is a necessary widening, but it is only people looking for a more convenient way to get to their destination.



96th Street Corridor Study

Michigan Rd. to Keystone Av.

Public Meeting

Nora Elementary School

AGENDA

October 20, 1999

7:00 pm – 9:00 pm

1) Introductions *Steve Cunningham*	**(5 min)**
2) Project Overview *Steve Cunningham*	**(10 min)**
3) Findings and Recommendations *John Myers*	**(50 min)**
4) Public Comment	**(50 min)**
5) Wrap-up/Next Steps *Steve Cunningham*	**(5 min)**

Public Meeting
Clay Township Community Center
Wednesday October 20, 1999
Attendance: 120

Speakers:
Steve Cunningham/DMD, John Myers/PB

SC – Main reason for public meeting is to inform the general public about the study and give them an open forum to discuss issues.

Questions/Comments:

- Is there a possibility for another interchange between Michigan Rd. and Keystone Av.?
- How did we define vacant land?
- What is the status of the Gibraltar proposal?
- Something has to be done to improve Westfield Blvd.
- When any improvements are made to the 96th St. corridor, won't it bring more traffic onto 96th St. and thus the need for a connecting bridge?
- What are the classifications for 96th St.?
- If 96th St. is improved in some way, will they use noise reduction measures?
- Currently the problem is not traffic volumes, but intersection delays.
- If a roundabout would work at Spring Mill, then shouldn't they look at the fact that a signal put in by the Duke development would prevent the roundabout from working?
- Won't you end up with disjointed planning if there have been several studies done in the same area?
- What if the entrance to Duke had to use a roundabout, could you then have one at Spring Mill?
- What is the status of the Duke development?
- Will any intersection improvements affect the SW corner of 96th St./Towne Rd.? If so, will you please inform the homeowners association?
- Roundabouts can be confusing, especially to the elderly. Will there be any educating the public on how to use a roundabout?
- Wouldn't it be beneficial to have a consistent RoW along the length of 96th St.?
- How much communication do you have with INDOT? How is the study funded? Will any federal funds be used if improvements are made?
- Is there a timetable for the study?

- Something needs to be done now at the intersections.
- Is there going to be an expediential effect on 96th St. that result from any improvements? Does the study address this?
- Have you looked at "If you build it they will come?" scenario?
- I find it very interesting that there is no representative from the Hamilton Co. Hwy Dept. Why is it that Indianapolis always tells Hamilton Co. what to do concerning issues on 96th St.?
- Nobody has mailed me anything about this study. How can we stay informed?
- If it is determined that 96th St. will be widened, how expensive and inconvenient will it be?
- It seems like the roundabouts are the best solution.
- PR – the study is not aimed at putting more asphalt down.
- Is there any historical precedent that the capacity of the roadway limits the land use?
- If they close Spring Mill Rd., what will you do at 96th St.?
- As a resident of 110th St./Westfield, I have noticed a tremendous change in traffic volumes since the White River bridge has gone in.
- How does the RoW affect properties?
- People along Spring Mill don't want it closed, they just want something done and done right.
- Who would pay for any property compensation?

MEMORANDUM

TO: John Myers, Parsons Brinckerhoff

FROM: Steve Cunningham, Indianapolis MPO

DATE: November 8, 1999

RE: Public comments on draft 96th Street Corridor Study

The draft report was made available to the general public for review and comment on October 10, 1999 in a number of locations. Locations included the Nora Public Library, Clay Township Government Center, City of Carmel Department of Community Service and in the offices of the Indianapolis MPO in 1841 of the City-County Building. In addition, the Findings and Recommendations were posted on the MPO's website. Ten written or e-mailed comments have been received since October 10th in addition to the comments made verbally at the public meeting on October 20th. The comments are summarized below:

- Very pleased to see alternatives to traffic signals.
- I am concerned about the impacts to Calvary Cemetery at the northwest corner of 96th and Shelborne Road. Indiana State Law prohibits granting of easements for anything upon a cemetery. Don't see the necessity of a roundabout at 96th and Shelborne.
- Pedestrians and bicyclists should be given every right to use 96th Street and their safety should be a top priority.
- Most commendable to position roundabout so as to take advantage of vacant land. Please consider widening 96th Street between Shelborne Road and Elm Drive to accommodate commercial traffic into and out of Park 421.
- If you plan to expand 96th Street to 4 lanes between Meridian and College and move the curb line south, you may as well take the entire row of houses on the south side of 96th. The more expansion the more our property values will go down.
- The 96th Street corridor needs widening from College to the east including a bridge over or tunnel under I-465. A sidewalk or multi-use path is needed along 96th Street east of College to connect the Five Seasons sidewalk to the Monon trail.
- The circles on Hazel Dell are too narrow and dangerous. People don't slow down and yield as they should. I hope you will reconsider all these roundabout projects. They need further investigation.

- We appreciate the weight you have given to keeping this section of 96th Street residential in nature. My family and I are very much in favor of roundabouts. We realize this are only recommendations. How can we influence the decision making process to insure these recommendations are done? Multi-use paths would be wonderful. Thanks for a great job on the study.

- We have read the 96th Street Study and largely support its findings and recommendations. We particulary endorse the elements summarized below:
  -Improvements should support and enhance the residential character of the neighborhood.
  -86th, 116th and I-465 should be focus of addressing long-term regional needs
  -We believe modern roundabouts are much preferable to traffic signals
  -Development proposals should have traffic plans that minimize impact of traffic on 96th Street
  -Where possible, right-of-way for widening should be taken from undeveloped land.

- I have suggested roundabouts in the past and have not found the DOT receptive to them. They have numerous advantages which I have provided and I must commend you in your consideration of roundabouts.

Appendix B: RELATED STUDIES

Special Area Study:
96th Street and Westfield Boulevard Transportation and Land Use Study
HNTB Corp. – June 1997

Study Purpose - The study addresses land use and transportation planning issues regarding the development of the area around the 96th Street/Westfield Boulevard Intersection.

Issues Addressed - Viable reconfigurations of 96th Street and Westfield Boulevard Appropriate land use options

Process Overview - The study was sponsored by the City of Indianapolis and the City of Carmel. A major issue was the possibility of connecting 96th Street over or under I-465 and the potential land uses for vacant land in the study area.

Transportation Options - Six alternatives for 96th Street alignment were evaluated. The alternatives evolved from past studies, staff input and suggestions from citizens.

1) Modified Existing – Modify Westfield Boulevard To provide a northbound left turn lane at Real Street and a northbound right turn lane at 96th Street The bridge over I-465 would be widen to accommodate the changes. Cost: $850,000

2) "S"-Curve – This option involves the construction of an "S" shaped roadway under I-465 through the Monon Corridor. Cost: $2.7 million

3) Modified "S"-Curve – Modified version of Alt. 2, with better roadway geometry. Would require reconstruction of I-465 bridge. Cost: $4.7 million (2 lanes), $6.9 million (4 lanes)

4) 96th Street Bridge – Construction of a new bridge over I-465 connecting 96th Street on both sides. Cost: $2.9 million (2 lanes), $4.5 million (4 lanes)

5) 96th Street Bridge "Skewed" – Modified Alt. 4 with bridge skewed at an angle reducing total size of bridge. Cost: $2.2 million (2 lanes), $3.3 million (4 lanes)

6) 96th to 101st Street Connector Road – Construction of a new roadway connecting 96th Street at Westfield Boulevard to College Avenue or Pennsylvania via 101st Street Cost: $3.2 million (College Avenue), $3.9million (Penn. Street)

Land Use Scenarios - Four land use scenarios were developed for an 80-acre parcel at the northwest corner of 96th Street and Westfield Boulevard

1) Regional Office Park – (500,000-sq. ft.) Assumes the site is fully developed with 3 to 5 story office buildings. Generated Trips: 5,710 daily

2) Neighborhood Commercial Center – (100,000-sq. ft.) Represents retail use of the site. Generated Trips: 7,068 daily total , 4,948 daily pass-by

3) Residential Development – (960 units/12 units per acre) Assumes apartments or condos are developed. Generated Trips: 9,168 daily

4) Residential Development – (240 units/3 units per acre) Development of single family homes in accordance with existing zoning and current local area comprehensive plans. Generated Trips: 2,292 daily

Public Issues and Concerns - Over 100 people attended the public meetings to discuss the project, a high degree of interest by local citizens. A majority of the comments related to maintaining the residential character of the 96th Street corridor. Concerns were also expressed about maintaining options for the Monon Trail through the study area. The overriding conclusion is that residents want to maintain the residential character of the area, as reflected in current Comprehensive Plans, and would prefer to make roadway changes only to the extent necessary to address local needs. A petition was signed by over 400 local residents, urging the Carmel/Clay Plan Commission to take actions to see that areas fronting 96th Street west of Meridian Street are residential in character.

Conclusions and Recommendations - 96th Street and Westfield Boulevard will continue to operate at accepted levels of service if the vacant land in the study area is developed as a maximum of 3 dwelling units per acre as proposed by the Carmel/Clay Comprehensive Plan. Public input is strongly in favor of keeping the area residential in character and would prefer to make roadway improvements only to the extent necessary to address local needs.

- **Southwest Quadrant – I-465 and U.S. 31**
  Traffic Impact Analysis Study
  HNTB, Corp. – April, 1998

Project Location - Southwest quadrant of I-465 and U.S. 31 bordered by Spring Mill Road on the west and 96th Street to the south.

Study Purpose - Identify the effects of the proposed development strategy to rezone the entire area to B-5 (General Office). These effects include traffic operations and residential impacts.

Study Objectives -

1) Estimate future 2007 horizon year traffic volumes within the study area based on growth, anticipated non-site development, and possible on-site development plans.

2) Assess the traffic impacts that the site development will have on three critical intersections (96th Street/Meridian Street, 96th Street/Spring Mill Road, 91st Street/Spring Mill Road) and determine what improvements will be required to reach an acceptable level of service (LOS D).

3) Evaluate the impacts that future development might have on cut-through traffic in adjacent residential areas and make recommendations on how to mitigate potential problems.

Three horizon year development conditions were considered in the study.

1) The site remains undeveloped.
2) The site is developed consistent with the current zoning (80% Medium Intensity Residential/20% General Office) and comprehensive plan.
3) The site is developed under proposed zoning.

Improvement Analysis - Various improvements are required for each subject intersection in order to operate at an acceptable LOS at the base year and for each development scenario.

1997 Base Year – All three intersections operate adequately under existing conditions, with the exception of 91st Street/Spring Mill Road operating below LOS D during the P.M. peak hour. The intersection at 96th Street/Spring Mill Road, as the results of a Traffic Signal Warrant analysis, satisfies the minimum requirements for the installation of a traffic signal. For the 91Street Street/Spring Mill Road intersection, a signal is not warranted.

2007 Horizon Year without Site Development – All three intersections fall below LOS D. The following improvements are necessary:

- 96th Street/Meridian Street
  - Addition of a fourth SB through lane.
  - Addition of a second NB,EB and WB exclusive left turn lane.
  - Addition of NB and EB exclusive right turn lanes.
  - Addition of two WB right turn lanes.
- 96th Street/Spring Mill Road
  - Addition of an actuated traffic signal.
  - Addition of NB, SB, EB, and WB exclusive left turn lanes.
  - Addition of a NB exclusive right turn lane.
- 91st Street/Spring Mill Road
  - Addition of an actuated traffic signal
  - Addition of NB, SB, EB and WB exclusive left turn lanes.

2007 Horizon Year with Existing Zoning – No additional improvements were required for the intersections at 96th Street/Spring Mill Road and 91st Street/Spring Mill Road other than the recommended improvements specified above. The following additional improvements should be made to 96th Street/Meridian Street to provide for LOS D operation:

- Addition of a fifth NB through lane.

2007 Horizon Year with Proposed Zoning - No additional improvements were required for the intersections at 96th Street/Spring Mill Road and 91st Street/Spring Mill Road other than the recommended improvements specified above. During peak PM hour, LOS E can be made if the following improvements are done to the 96th Street/Meridian Street intersection:

- Addition of a fifth NB through lane.
- Addition of a third SB exclusive left turn lane.
- Addition of a second SB exclusive right turn lane.
- Addition of a second EB exclusive right turn lane.

Additional DCAM Analysis - DCAM studied the 96th Street/Meridian Street intersection using the Critical Lane Volume (CLV) analysis method instead of the Highway Capacity Manual (HCM) which HNTB used. Research conducted by DCAM revealed that in most cases the CLV method compared favorably with the HCM method. However, in fully saturated conditions the HCM method of analysis may not have accurately represented left turn delays. The DCAM CLV analysis indicated that modifications were still necessary in order to accommodate Horizon Year traffic volumes.

Findings and Recommendations - The results of the Traffic Impact Study indicate that many traffic system improvements are required in order to effectively accommodate the projected future volumes of traffic that will develop from annual background growth and

anticipated non-site development (horizon year base conditions). The development of the subject site under existing or proposed zoning conditions should not negatively impact adjacent residential areas. If the recommended improvements are made at the two intersections on Spring Mill Road, Residential cut-through traffic will not increase as a result of development or future growth. With the installation of traffic signals and exclusive turning lanes, vehicular delays will be reduced; therefore, making it less attractive for drivers to avoid this intersection by cutting through adjacent neighborhoods. In a deliberate effort to keep with the trend set forth by the community and the Carmel City County Council and Plan Commission, a conscious effort has been made to preserve Spring Mill Road as a local neighborhood road with little through traffic. The installation of traffic signals will not detract from this effort. The actuated traffic signals will reduce driver delays by providing for adequate movement through intersections that are experiencing congestion even under current conditions. The capacity of Spring Mill Road will remain the same since the road itself is not to be widened.

- **Intersection Improvement Study**
  Ditch Road & 96th Street/106th Street/116th Street
  First Group Engineering, Inc. – August 1998

  Recommendations - Ditch Road and 96th Street – A traffic signal is recommended at this intersection. The signal is to be fully actuated and include a left turn arrow for the westbound traffic turning south. Left turn lanes are recommended on all approaches and a right turn lane is recommended for northbound traffic turning east. Ditch Road widening is to take place on the east side of the road to lessen the impact to the homes on the west side of Ditch Road The 96th Street widening is to take place on both the north and south sides of the roadway. This will equalize the impact of this improvement on the homes on the north and south sides of 96th Street

- **Spring Mill Road Intersections – A Traffic Signal Warrant Analysis and Evaluation of Alternatives**
  ACE, Inc. – September, 1998

Spring Mill Road and 96th Street:

Existing Conditions – ACE conducted machine and manual turning movement counts at the intersection on July 14, 1998. The intersection is currently serving nearly 14,000 vehicles on 96th Street and approximately 7,600 vehicles on Spring Mill Road per day. From the manual counts, these corridors are serving the motorists as designated in the Thoroughfare Plan (Carmel/Clay Comprehensive Plan), as minor arterials and collectors. During the peak hours, 20-25% of the traffic is making turning movements at these intersections to gain access to, or distribute from, the major arterials in the area. The four-way stop control is currently able to provide an acceptable level of service although during peak periods as many as 25 vehicles were observed backed up at the intersection. Average delay per vehicle at this intersection is computed at over 17 seconds in the AM peak hour and over 24 seconds during the PM peak hour. These delays equate to increased fuel consumption, increased airborne pollutants, driver frustration and wasted time for the motorists.

Traffic Signal Warrant Analysis – Based upon the current traffic volumes, this intersection meets the IMUTCD requirements for two of the three primary warrants. Accidents at this location have been analyzed previously and this intersection is historically one of the highest accident locations in Hamilton County.

Roadway Improvements – The installation of a traffic signal without additional lanes to serve the high percentage of turning movements would actually increase delays at the intersection. Through capacity analysis of different improvement scenarios, it is recommended to include right and left turn lanes on each approach of the intersection. The minimum length that should be considered for these turn lanes should be the designed length for deceleration plus the length for the anticipated design year storage volumes. Although the INDOT design manual and the AASHTO guidelines allow, under restrictive conditions, a reduction in this minimum length, it is felt the full length turn lanes should be constructed at this time. It was noted, at the public meeting, the existing pavement is distressed and should be reconstructed in conjunction with this improvement.

Recommendation for Improvements – This intersection improvement should consist of the total reconstruction of the existing roadway with the addition of full designed length right and left turn lanes in each direction. A curb and gutter section should be utilized to minimize right-of-way and space should be provided for a future multi-use path. A traffic signal should be included in the improvements. *Estimated Cost* - $1,080,000

- **Traffic Study/Intersection Improvements**
  Towne Road & 96th Street, 106th Street, 116th Street, and 146th Street
  Beam, Longest and Neff, L.L.C. – October 1998

Methodology - Each of the intersections being studied had peak hour (AM and PM) turning movement counts performed. The intersections were manually counted between the hours of 6 to 9 AM and 3 to 6 PM. Volume counters were placed at the Towne Road intersections of 96th Street and 116th Street These counters were in place for a 48 hour period and were used to confirm the peak hours for the turning movement counts. The peak hour volumes were then projected to the design year (2020). Population growth and vehicle registrations were reviewed from 1980 to the present, to develop the design year projections. Data from 1990 to 1997 indicated increases of over 5% per year.

Analysis - The Highway Capacity Manual (HCM) and the Highway Capacity Software (HCS-2.g) were utilized to calculate a level of service (LOS) for the existing condition and design year alternatives for each of the intersections.

Towne Road & 96th Street:

Each approach of the existing intersection contains 2 lanes (1 each direction) with traffic control provided by means of a 4-way stop. Due to the uneven distribution and high volumes of traffic due to peak periods, it is not possible to calculate the current LOS at this location.

In the design year (2020) a traffic signal will be necessary at this intersection to obtain a desirable level of service. Four different geometric configurations for a signalized intersection were analyzed.

1. A six-lane section on all four approaches: 2 through lanes, 1 left turn lane and 1 right turn lane. Due to the high volumes of traffic on all movements, it was not possible to obtain a desirable LOS with this layout.

2. The eastern and southern approaches have very high left turn volumes, therefore this alternative considers the use of double left turn lanes. The resulting layout is 2 through lanes, 2 left turn and 1 right turn on the east and south approaches and 2 through, 1 left turn, 1 right turn on the west and north approaches. This configuration resulted in an overall intersection LOS of D for peak periods.

3. The layout for the third alternative was a seven-lane section on all approaches: 2 through lanes, 2 left turn and 1 right turn lane. The addition of the double left turn lane to the north and west approach did not result in any improvement of the LOS.

4. The last alternative investigated the following lane layout: 3 through lanes, 2 let turn and 1 right turn lane on Towne Road and 2 through, 2 left turn and 1 right turn lane on 96th Street Analysis of this alternative resulted in a reduced intersection delay time, but did not increase the over-all intersection LOS above D.

Recommendation - It is recommended that the layout as described in the second alternative be utilized for the intersection design. The configuration for this alternative provides 2 through lanes and 1 right turn lane on all approaches; double left turn lanes on the east and south approaches, and single left turn lanes on the west and north approaches. Although this alternative allows a LOS D, none of the other alternatives were able to improve this value. This alternative also reduces the amount of right-of-way needed as compared to the other proposed alternatives.

- **Traffic Impact Analysis – Proposed Residential Development**
  96th Street and Westfield Boulevard, Carmel, IN
  A & F Engineering Co., Inc. – October, 1998

Purpose - The purpose of this analysis is to determine what effect traffic generated by a proposed residential multi-family development (360 units) would have on the existing adjacent roadway system. The study area is bounded by Keystone Avenue on the east, 106th Street on the north, Westfield Boulevard on the west and Real Street on the south.

Analysis -

- Traffic volume counts at each intersection.
- Estimate number of new trips generated from 3 scenarios of development: proposed development, vacant land development and comprehensive plan development.
- Assign generated traffic volumes to roadways that will serve the proposed development.
- Distribute the developed traffic volumes onto existing roadways.
- Prepare analysis for LOS for five different development scenarios.
  1. Existing Conditions
  2. Vacant Land – Add Horizon Year 2008 traffic volumes.
  3. Comprehensive Plan – Add traffic volumes that would be generated by land use development as proposed by the comprehensive plan.
  4. Proposed Development with Two Exclusive Entrances
  5. Proposed Development with Entrance at 96th Street

Conclusion - The proposed 360 unit multi-family development plus the added Horizon Year 2008 traffic volumes will effect the existing intersections as such:

1. 96th Street & Westfield Boulevard will continue to operate at acceptable levels with only an exclusive right turn lane added to the northbound approach of the intersection.

2. Real Street & Westfield Boulevard will operate at acceptable levels with the addition of signalization.

Summary - The proposed residential development will not adversely affect the operation of the public roadway system to a greater extent than the land use recommendation by the Carmel/Clay Comprehensive Plan. Field observations and a queuing analysis has determined that an access point to the proposed development should not be constructed on the eastbound approach of 96th Street and Westfield Boulevard Alternatively, two access points should be constructed along Westfield Boulevard between 96th Street and the proposed development's north property line.

Appendix C: LEVEL OF SERVICE CONCEPTS

The description of the several service levels is easier for freeways, because the range of speeds and volumes included is greatest. It is rather difficult to do for urban arterials, because of the limited speed range, and must be handled in a different way for intersections where speed has only indirect meaning. For illustrative purposes, therefore, freeways are described here.

Level of service A is the highest quality of service a particular class of highway can provide. It is a condition of free flow in which there is little or no restriction on speed or maneuverability caused by the presence of other vehicles. On a freeway, lane density is approximately 10 vehicles per mile, and the volume/capacity ration is typically about 1:3. Because speeds are high and volumes low, the occurrence rate of some kinds of accidents may be higher that at other service levels and the total economic cost of providing the service may be excessive.

Level of service B is a zone of stable flow. However, operating speed is beginning to be restricted by other traffic. Under freeway conditions, lane density is under 20 veh/mi, restriction on maneuverability is still negligible, and there is little probability of major reduction in speed or flow rate. This level of service approximates typical design volumes for high-type rural highways, including freeways.

Level of service C is still a zone of stable flow but at this volume and density level most drivers are becoming restricted on their freedom to select speed, change lanes, or pass. Operating speeds are still in the range of two-thirds to three-fourths of maximum; lane density reaches from 30 to 35 veh/mi on freeways. This service level is frequently selected as being appropriate criterion for design purposes, particularly for urban freeways, where the cost of providing the higher service level during peak periods may be prohibitive.

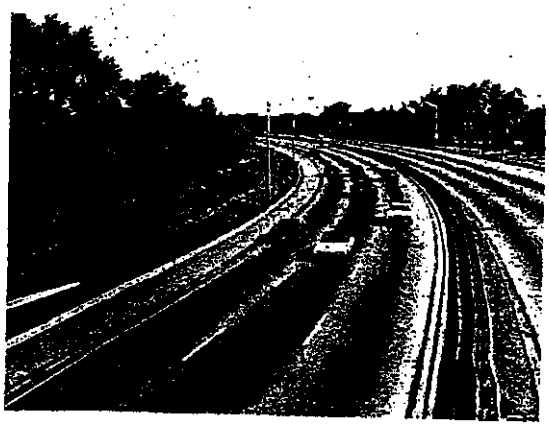
Level of service D approaches unstable flow. Tolerable average operating speeds are maintained but are subject to considerable and sudden variation. Freedom to maneuver and driving comfort are low because lane density may reach as high as 45 to 50 veh/mi, and the probability of accidents has increased. Most drivers would consider this service level undesirable.

The upper limit of service E is the capacity of the facility. Operation at this level of service is unstable, and speeds for uninterrupted-flow highway types are about 30 mph but will fluctuate widely from point to point. There is little independence of speed selection and maneuverability. Lane density normally reaches about 70 to 75 veh/mi. Since headways are short and operating speeds subject to rapid fluctuation, driving comfort is low and accident potential is high. Although circumstances may make operation of facilities under these conditions necessary, it is clearly unsatisfactory and should be avoided whenever feasible.

Level of service F describes forced-flow operations. Speed and rate of flow and below the levels attained in level E and may, for short time periods, drop to zero. Density, on the other hand, continues to increase, eventually reaching "jam density" of about 150 veh/mi in stoppages.

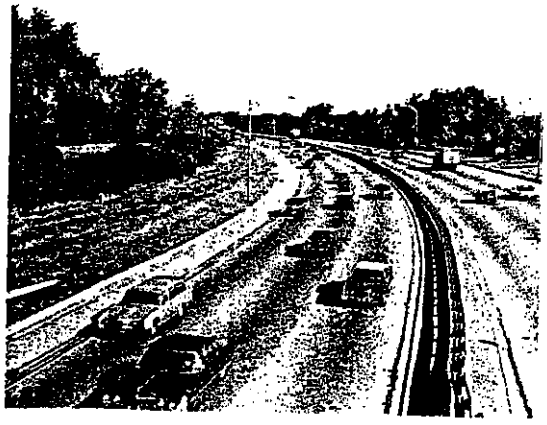
Level of service A as viewed looking up stream on a typical freeway indicating no physical restrictions on operating speeds. SOURCE: Illinois Department of Transportation.

Level of service D as viewed looking up stream on a typical freeway indicating approaching unstable flow, little freedom to maneuver, and condition tolerable for short periods. SOURCE: Illinois Department of Transportation.



Level of service B as viewed looking up stream on a typical freeway indicating stable flow with few restrictions on operating speed. SOURCE: Illinois Department of Transportation.

Level of service E as viewed looking up stream on a typical freeway indicating unstable flow, lower operating speeds than level D and some momentary stoppages. SOURCE: Illinois Department of Transportation.



Level of service C as viewed looking up stream on a typical freeway indicating stable flow, higher volume, and more restrictions on speed and lane changing. SOURCE: Illinois Department of Transportation.

Level of service F as viewed looking up stream on a typical freeway indicating forced flow operation at low speeds where the highway acts as a storage area and there are many stoppages. SOURCE: Illinois Department of Transportation.

WIDE NOADS AND

NARROW ROADS

© by Leif Ourston, P.E.
Leif Ourston & Associates
5290 Overpass Road, Suite 212
Santa Barbara, California 93110
Telephone 805 683-1383

Paper presented to the
Transportation Research Board
72nd Annual Meeting
January 10-14, 1993
Washington, D.C.

WIDE NODES AND NARROW ROADS

by Leif Ourston, P.E.
Leif Ourston & Associates, Santa Barbara, California

Paper presented to the
Transportation Research Board
72nd Annual Meeting
January 10-14, 1993
Washington, D.C.

ABSTRACT

Compared to typically wide American arterials which intersect at signalized cross intersections, a roundabout-based road system, like the system of main roads in the United Kingdom, uses wide "nodes" (roundabouts) and narrow "roads" (links), for an overall saving of pavement, bridge area, and land. An important economic advantage of modern roundabouts is to save money between roundabouts by using narrower road links.

The difference between modern roundabouts and nonconforming traffic circles is in the guidelines they follow. Modern roundabouts follow modern guidelines; nonconforming traffic circles do not. Among other features, modern guidelines recommend yield at entry, deflection, and flare, characteristics that give the modern roundabout great safety and high capacity in a compact space.

The effect of modern roundabouts on highway engineering is revolutionary as they proliferate from country to country. Four states are funding modern roundabout work here. Seven modern roundabout interchanges have been proposed, and the Federal Highway Administration has approved one of them.

Freeway-to-street interchanges are the most cost effective place to use modern roundabouts because their potentially "narrow roads" include expensive bridges. If additional capacity is needed at ramp and frontage road intersections, it is often far less expensive to convert those intersections to high capacity modern roundabouts than to widen an undercrossing or overcrossing or to build loop ramps.

MODERN ROUNDABOUTS REDUCE THE COST OF MAIN ROADS

Much has been said about the value of modern roundabouts to reduce road user costs, the costs of accidents, delay, and fuel waste. Often overlooked is the important capital cost saving contribution of roundabouts: Roundabouts allow the use of narrower link roads joining them, for an overall reduction of pavement, land, and bridge area in the road system (Figures 1, 2, and 3).

The wide-nodes-and-narrow-roads planning principle refers to the use of wide roundabout intersections (nodes) joined by narrow links (roads). With roundabouts, node capacity approaches link capacity partly because the number of lanes in the roundabout is usually greater than the number of lanes moving in each direction on the link.

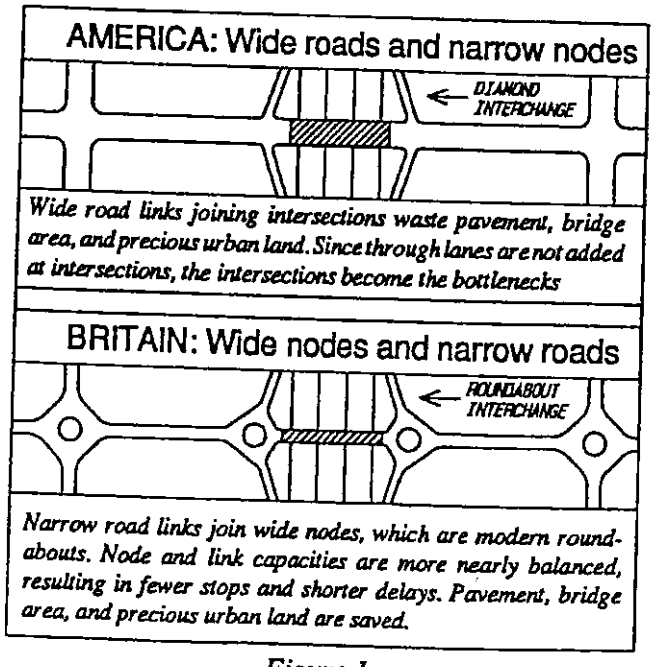


Figure 1

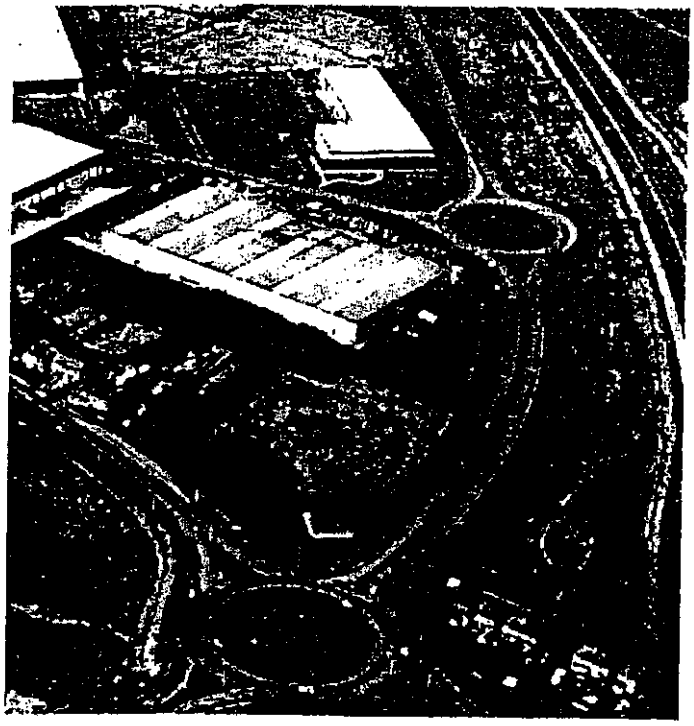


Figure 2

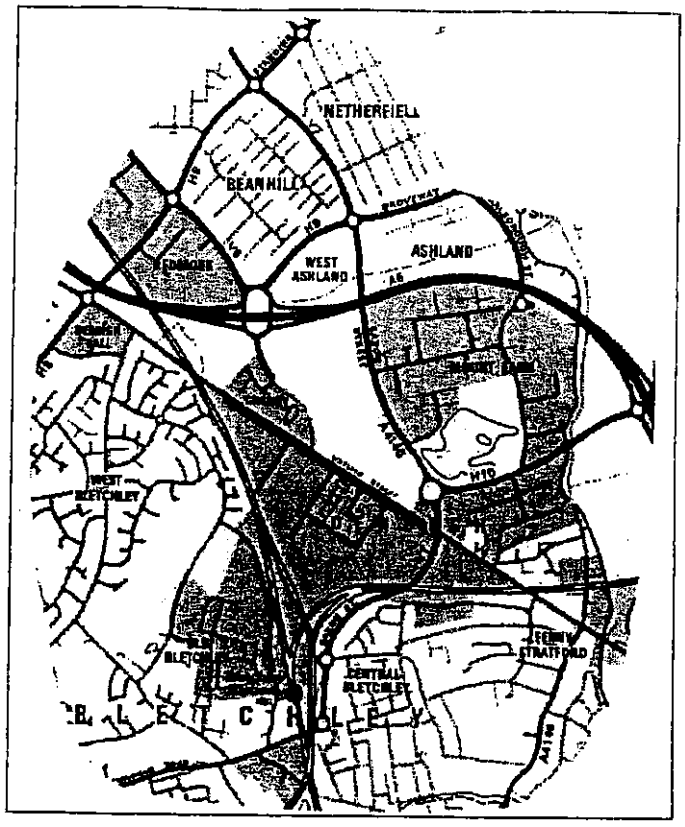


Figure 3

British roads use modern roundabouts at most important at-grade crossings and freeway-to-street interchanges. New towns of Warrington (left) and Milton Keynes are shown above.

For example, a one-lane approach usually flares out to two or three lanes at the roundabout, and a two-lane approach usually flares out to three or four lanes (Figures 4, 5, and 15). Roundabout capacity is further increased by use of right turn bypass lanes, lanes that enable drivers requiring the first available exit to bypass the roundabout altogether (Figures 5, 10, 15, 17, and 18).

But before explaining how wide nodes permit the use of narrow roads, it is first necessary to answer the question:

Figure 4

A wide four-lane node makes possible a narrow road having two lanes in each direction, for an overall savings of pavement, land, and bridge area.

WHAT IS A MODERN ROUNDABOUT?

Circular intersections fall into two categories: Modern roundabouts and nonconforming traffic circles. Modern roundabouts conform to one of a few sets of foreign guidelines that are patterned after British guidelines. By contrast, nonconforming traffic circles do not conform to the guidelines for modern roundabouts.

If you live in North America, most of the circular intersections that you are likely to have driven are nonconforming traffic circles. For example, all but four of the circular intersections in the United States, all of the circular intersections in Canada, Mexico, Belgium, and

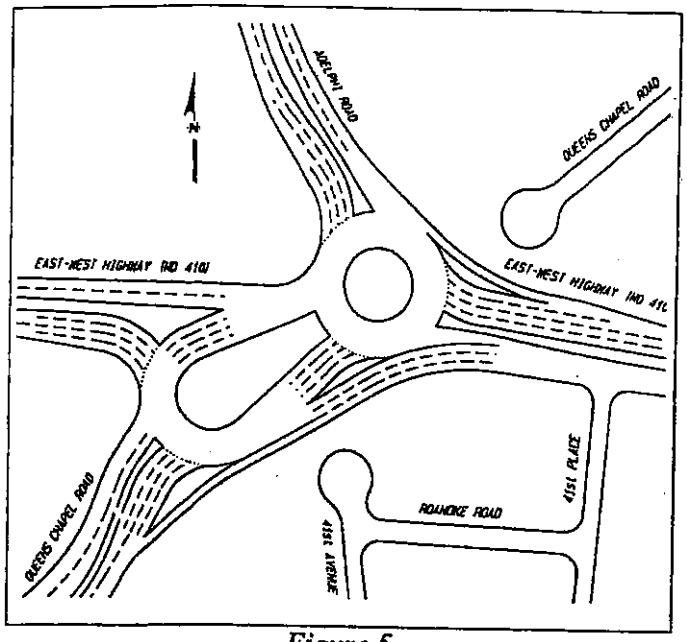


Figure 5

College Park Roundabout, College Park, MD. ICD=200', each end. 2010 DHV=7000 vph. A double roundabout proposed to relieve congestion at a complex intersection. Modern roundabout design uses many entry lanes, multiple central islands, and bypass lanes to increase capacity as necessary. Designer, Ourston.

Italy, and many of the older French circular intersections are nonconforming traffic circles. Generally, they handle light flows of traffic satisfactorily, but they fail as traffic demand approaches capacity.

By contrast, modern roundabouts can carry more traffic than any other type of at-grade intersection. The highest capacities, of around 8,000 vehicles per hour, are achieved by wide entries, bypass lanes, and double roundabouts (Figure 5). In the United Kingdom, at locations which require high capacity, the modern roundabout is the intersection of choice. For example, almost all British freeway-to-street interchanges are based on the modern roundabout (Figure 6), and the first intersection at the end of a freeway in Britain is usually a modern roundabout.

Superior Performance of Modern Roundabouts

It is not possible to list all the guidelines of modern roundabout design here, but among other features, modern roundabouts have two fundamental design elements: *Yield at entry* and *deflection* of the vehicle path (Figure 7). A third fundamental feature, entry *flare*, is essential for high capacity. It is found in many, but not all, modern roundabouts. In lieu of YIELD signs, one or more entries to some modern roundabouts are regulated by traffic signals.

The three fundamental differences give modern roundabouts important advantages over nonconforming traffic circles.

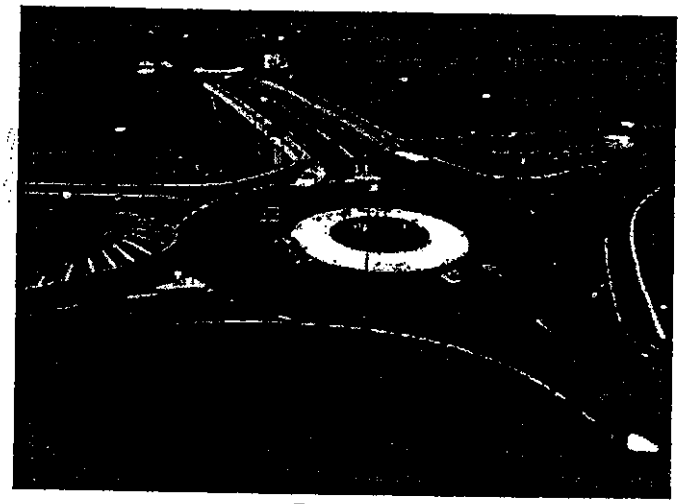


Figure 6

Wide nodes and narrow roads save the most money at interchanges. Wide nodes permit the road between them, which contains an expensive bridge, to be narrow. Two lanes always moving on the structure do the work of four stopped half the time at red lights.

Yield at Entry

At modern roundabouts entering traffic yields the right of way to circulating traffic. Since entry is by gap acceptance, not by weaving, long weaving sections between entries and exits are no longer required.

For this reason modern roundabouts are compact. Modern roundabouts with raised central islands fit into an inscribed circle of 100 to 300 feet in diameter. Miniroundabouts—having traversable central islands, either flat or in the shape of a dome up to five inches high—fit into the smallest intersections. Being compact, modern roundabouts are a type of intersection that can be used almost anywhere.

By contrast, conventional weaving entry rotaries are often 400 feet or more in diameter, limiting their application to a few rural and suburban sites. Their large radii encourage high speed.

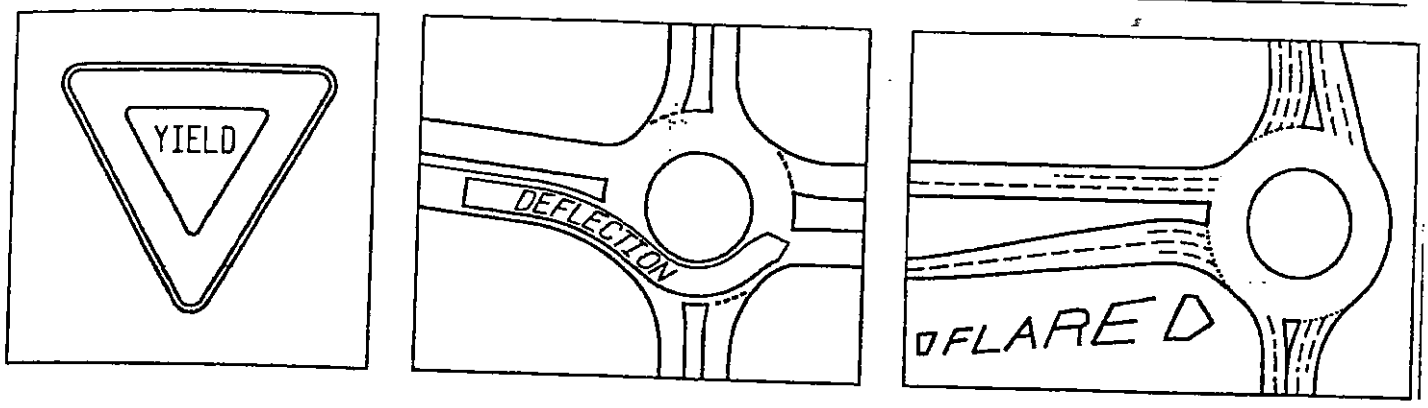


Figure 7: The three main features that distinguish modern roundabouts from nonconforming traffic circles are: yield at entry, deflection, and flare.

Deflection

The entry geometry of modern roundabouts deflects traffic through an arc whose radius is no longer than 328 feet (100 meters). By contrast, conventional traffic circles often have tangential entries which allow traffic to enter in a straight line at speed. Deflection of the vehicle path slows traffic, thus contributing to the good safety record of the modern roundabout. Entry deflection also reinforces the yielding process.

Flare

The entries to modern roundabouts often flare out from one lane on the approach road to two or three lanes at the yield line, or from two approach road lanes to three or four lanes at the yield line. Flare is the characteristic that gives the modern roundabout its great capacity in a compact space. By contrast, nonconforming traffic circles do not have flared entries.

Common Deviations of Nonconforming Traffic Circles

Most traffic circles in this country are one-off designs that do not conform to any guidelines. As such, they deviate from modern roundabout guidelines in ways that are unique to each site. Some of the more common deviations are:

1. Parking in the circle.
2. STOP signs regulating the entries.
3. No regulation of the entries.
4. Crosswalks leading to the central island.
5. Lane lines in the circle.
6. Channelization which causes circulating drivers to leave the circle before their desired exit.
7. Too wide or too narrow circulatory roadway width.
8. YIELD signs but no yield lines.
9. Inadequate sight distance.
10. Inadequate signing and lighting.

The Daytona Beach roundabout (Figure 8) illustrates the importance of deflection. Constructed in 1949 with YIELD signs added later, this old circle is three-fourths modern and one-fourth old. The three approaches that have adequate deflection logged zero, one, and four

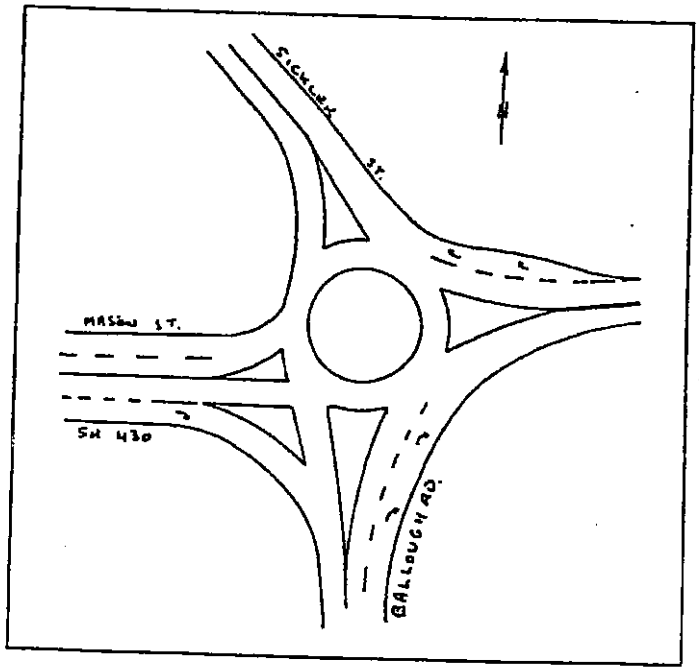


Figure 8

Daytona Beach Traffic Circle, Daytona Beach, FL. ICD=110'. PHV=2800 vph. Designer, unknown. Submitted by Wallwork.

accidents over the past four years. By contrast, the west approach, which has no deflection, was the site of seventeen accidents during the same period. The circle compares the benefits of modern design with old design at one location.

WIDE NODES PERMIT NARROW ROADS

Independence of link and node size

Roundabouts and the links joining them are sized independently. Links and nodes are designed just large enough so that the nodes have adequate capacity regardless of link width, and the links have adequate capacity regardless of node diameter. Link and roundabout sizes are blended by flaring the roundabout entry to add lanes just before the roundabout and by tapering the exit to drop a lane just after the roundabout (Figure 9).

Within modern roundabouts, since there are usually no lane lines, almost all of the merging is done at low speed just after entry, as three or four vehicles enter side-by-side at a multiple lane entry immediately move into a staggered single file type of alignment, with the front right corner of each vehicle just behind the left rear corner of the vehicle ahead of it. Within two or three car lengths of entry they are in single file or, rarely, in a double widely separated file. By the time they reach the exit they are usually in a single file. Merging at low speed shortly after entry is a safe, normal part of the operation of modern roundabouts. Since there are no lane lines, the transition does not seem or feel like merging.

By contrast, to drop though lanes after a cross intersection would require a high- or medium-speed merger, a dangerous maneuver, and an annoying one to impose on motorists if the number of lanes would spread out a short distance away at a traffic signal. The number of lanes on a link on conventional American roads is therefore determined by the requirements for

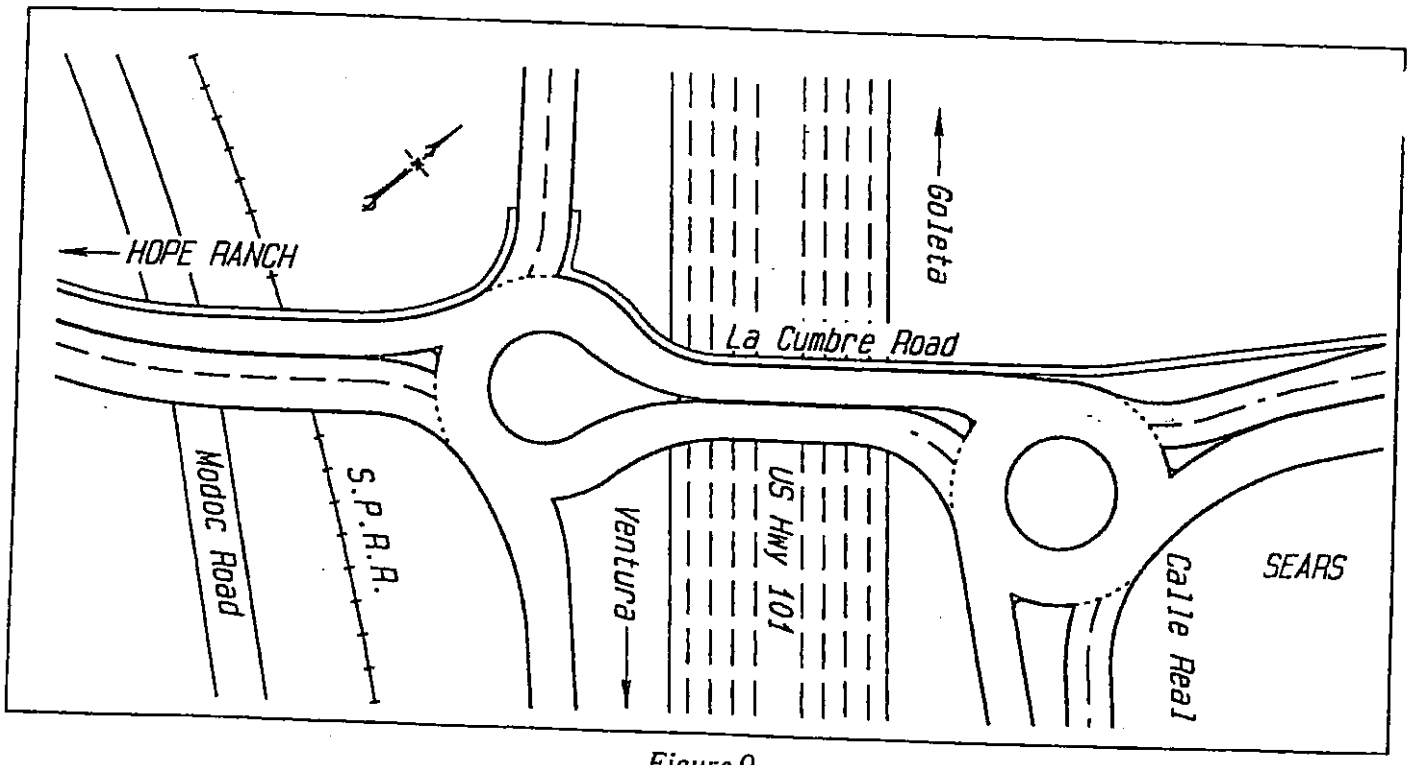


Figure 9

La Cumbre Road/U.S. Highway 101, Santa Barbara, CA. ICD=120'. DHV=2660 vph, north roundabout, 2600 vph, south roundabout. A modern raindrop interchange, the design is under environmental review by the Santa Barbara County Association of Governments as an alternative to the State's proposed widening. It would cost much less would reduce delay, accidents, fuel waste, and emissions, and would not require additional right of way. Designer, Doctors.

intersection capacity. Very often the capacity of a link far exceeds the flow of traffic on it. Inefficient traffic control at the nodes may cause long queues, giving the impression of very heavy traffic, while the actual flow of traffic through the link is quite low.

Sizing a link which joins a pair of modern roundabouts

The open road capacity of a link is about 1700 vehicles per lane-hour. If the unidirectional flow of traffic on the link will not exceed 1700 vehicles per hour, one lane in that direction may be all that is needed. If the flow falls between 1700 and 3400 vehicles per hour, two lanes are needed. Left turn lanes are not needed unless there are minor T-intersections and cross intersections between the major roundabout intersections. In any case, broad medians which would shadow double left turn lanes are not needed. Roundabouts cater to left turns without any specially assigned left turn lanes on the approaches.

In America, most four-lane roads and many six-lane roads do not carry more than 1700 vehicles per hour in one direction. Some of these roads would provide better service as two-lane roads with wide nodes. The links would be easier for pedestrians and side street traffic to cross, and the modern roundabouts would be safer and more efficient than signalized cross intersections.

Sizing a modern roundabout

Roundabout capacity is determined by six geometric parameters: entry width, upstream half-width (the width of the side of the link road carrying traffic toward the roundabout before it begins to flare out at the entry), length of flare, roundabout inscribed circle diameter (the outer diameter), entry angle, and the radius of the curb return at entry. Roundabout capacity is increased through use of wider entries (up to four lanes), longer flares, and bypass lanes. Additional capacity can be gained, if necessary, by splitting one four-leg roundabout into two three-leg roundabouts. This technique is especially useful if a heavy left turning flow can be eliminated from the circulating flow in front of a critical entry. By applying these techniques as necessary, a modern four-leg roundabout or double roundabout of about 250 feet inscribed circle diameter can be designed so that its capacity exceeds 8,000 passenger car units per hour. Depending on entry geometry and on the circulating flow of vehicles in front of the yield line, the capacity of a four-lane entry to a modern roundabout ranges from zero passenger car units per hour, with heavy circulating flow, to about 4,000 passenger car units per hour, with negligible circulating flow.

The capacity of modern roundabouts can be estimated to within about 15% by use of one of two programs from the United Kingdom, ARCADY and Rodel. Both programs are based on the same primary research, and although each program offers different features, insofar as their output overlaps, their estimates of capacity, delay, and queue lengths are equal. The license for each program costs about $1800 in America.

The knowledge of how to use modern roundabouts and narrow road links to economical advantage would have little importance to American highway engineers if modern roundabouts were strictly a British phenomenon, or if they were not recognized by state highway departments or by the Federal Highway Administration. Fortunately, things have changed from just a few years ago, and the modern roundabout revolution has spread to several countries, including our own.

ROUNDABOUT REVOLUTION COMES TO AMERICA

Proliferation of Modern Roundabouts Overseas

Because of their success and popularity, modern roundabouts are proliferating in about a dozen countries, including most British influenced countries like Australia, New Zealand, Ireland, South Africa, Barbados, and Bermuda, as well as France, Switzerland, Norway, Denmark, Sweden, Germany, Spain, Portugal, the Netherlands, and finally, the United States. For example:

- In France, since 1984 there has been an explosion in the population of roundabouts in many French towns. Roughly one thousand roundabouts were built in France in 1991.
- In Melbourne, Australia, there are about 1600 modern roundabouts, a density of one roundabout per 1800 residents. This represents an increase of about 700 roundabouts over the past seven years.

- In Switzerland, since 1987 when the yield at entry rule was adopted, the number of roundabouts has increased to about 100 from about 20.
- In Norway, YIELD signs were installed at all roundabouts beginning in 1985. The number of roundabouts there increased to about 600 by 1992 from around 50 in 1985. Roughly 100 roundabouts are built in Norway each year. Recently some signalized intersections have been converted to modern roundabouts.

Wide Nodes Planned and Proposed for the United States

Only four modern roundabouts have been built in the United States, two in Las Vegas in the spring of 1990, one in Gainesville in the spring of 1992, and one in Santa Barbara in November of 1992 (Figures 10, 11, 12, and 13).

Las Vegas, Gainesville, and Santa Barbara are pleased with their modern roundabouts. Contrary to the fears of skeptics who worried that Americans would not be able to drive modern roundabouts safely, there has only beer one accident at a modern American roundabout since th first ones were built here three years ago.

In addition to these first modern American roundabouts, four states are now funding modern roundabout work.

GLOSSARY
DHV - Future design hour volume vehicles/hour
PHV - Present peak hour volume vehicles/hour
ICD - Inscribed circle diameter, the outer diameter

California

District 7 of the California Department of Transportation, which includes Ventura and Los Angeles Counties, has funded roundabout projects since 1987. Their first proposed project was the Ojai roundabout, which would have replaced a signalized Y-intersection. That project was withdrawn because of organized opposition.

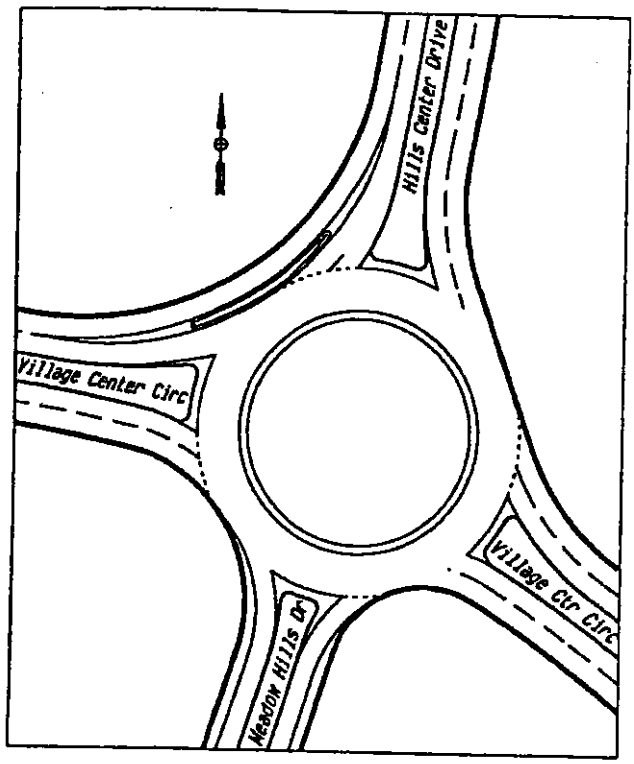


Figure 10, North Roundabout

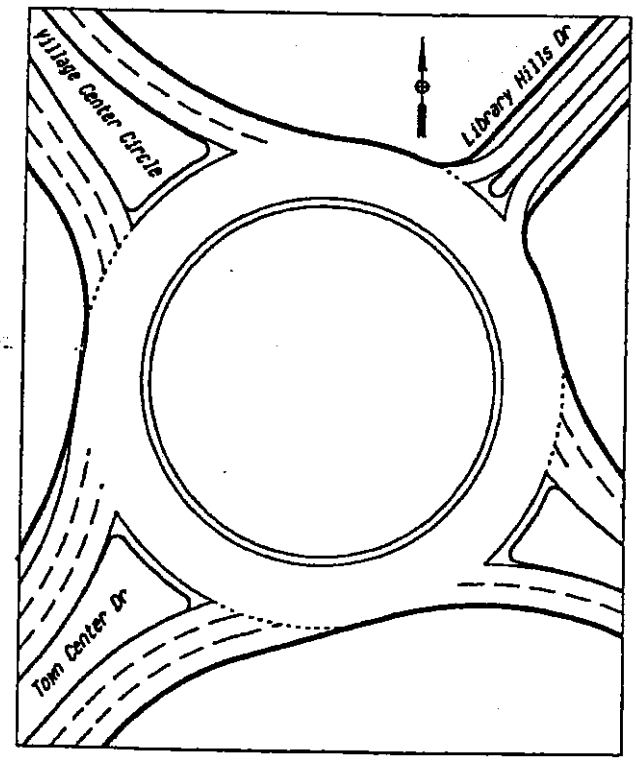


Figure 11, South Roundabout

North Roundabout (ICD=200'. DHV=3000 vph) and South Roundabout (ICD=300'. DHV=6000 vph), Las Vegas, NV. Constructed in spring of 1990, these two roundabouts are the first modern roundabouts in North America. Located at the end of the Summerlin Parkway, they are the focus of the community of Summerlin, a development which will one day have a population equal to that of present day Las Vegas. Designers, Ourston, Sprague, and O'Brien.

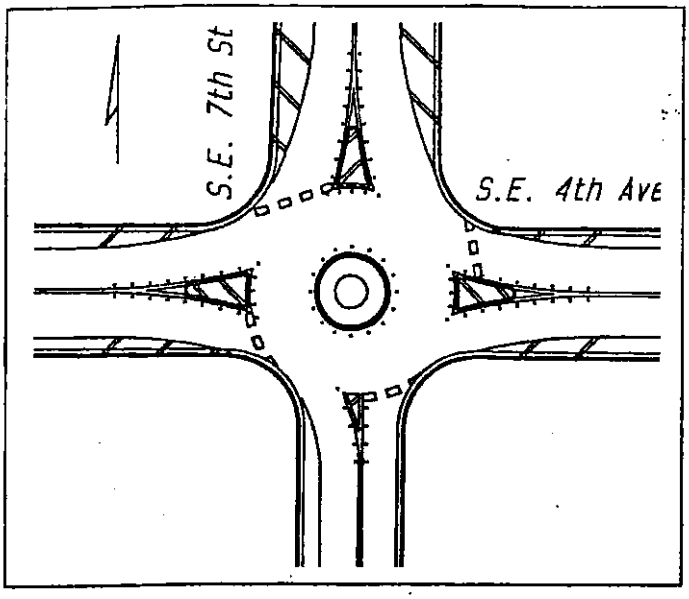


Figure 12

Gainesville Roundabout, Gainesville, FL. ICD=58'. PHV=500 vph. Constructed in April, 1992, this is the first modern American roundabout to replace a traffic signal. Because of its success, Gainesville is looking for other signals to replace with modern roundabouts. Designers, Kanely and Mann.

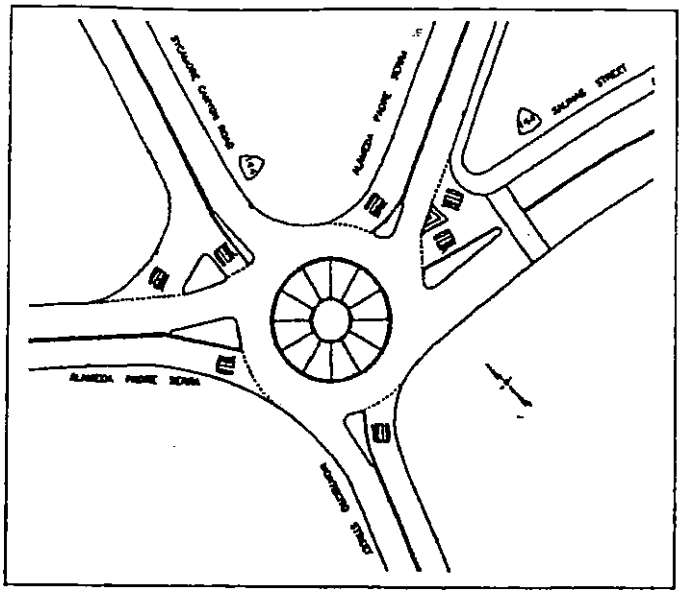


Figure 13

Five Points Roundabout, Santa Barbara, CA. ICD=86'. PHV=1500 vph. Working only one week in November, City of Santa Barbara maintenance crews replaced a 5-way STOP sign controlled intersection with the first modern roundabout on the California state highway system. Carrying a peak hour volume of 1500 vph, the Five Points roundabout is now the busiest of the four modern roundabouts in the United States. Peak hour queues, formerly up to thirty vehicles long, are now zero to four vehicles long. The learning process was easy and swift for most drivers; there have been no reported accidents. Designer, Doctors.

Now the Long Beach roundabout, to replace a large nonconforming traffic circle at the intersection of two state highways, is under construction (Figure 15).

District 7 has retained the author to study the feasibility of using modern roundabouts to solve safety and capacity problems at five sites. Caltrans has also commissioned the translation of the British roundabout design guidelines, and they have authorized a before-and-after study of the Long Beach roundabout. They have retained DKS Associates to study the feasibility of roundabouts at several sites.

Maryland

Since August of 1991 Maryland has funded feasibility studies of roundabouts at about a dozen sites. They have produced an eight-minute video, "Modern Roundabouts," to bring the concept to the public. (Call 410 787-5879 to request your copy.) A Roundabout Task Force, composed of state highway officials and traffic engineers of metropolitan counties, meets monthly to propose and discuss sites for modern roundabouts. Two roundabouts are in final design, and one, the Lisbon roundabout, will be built this spring (Figure 16).

Florida

The Florida Department of Transportation has sponsored several pedestrian safety and roundabout design courses by Michael Wallwork, Traffic Operations Engineer, and Dan Burton, Pedestrian-Bicycle Coordinator. Teaching techniques influenced by Wallwork's native Australia, the team has reached hundreds of engineers across Florida and other states. The team's most recent course, in Vermont, persuaded the governor that roundabouts have a future there.

Wallwork has written two papers on roundabouts, one of them for the *Compendium* of the 1990 annual ITE meeting, and he has written to *ITE Journal* on roundabouts. He has written parts of Florida DOT's Urban Mobility *Technical Assistance Manual* and *Pedestrian Safety Plan*, in which he recommends roundabouts to improve capacity and safety.

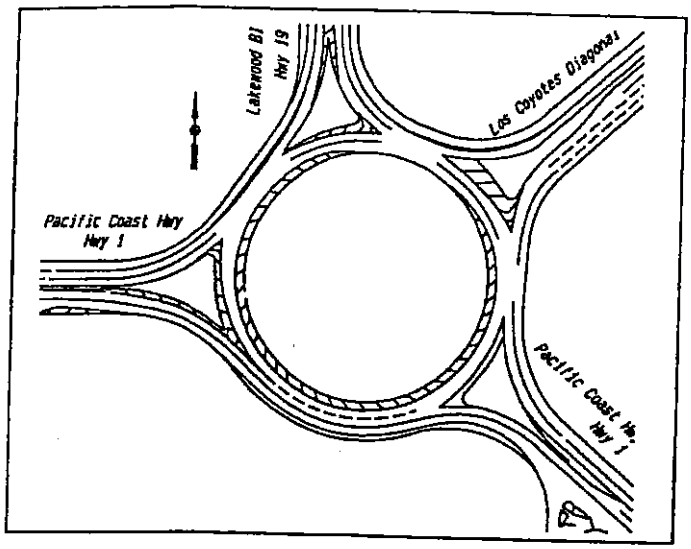


Figure 14, old Long Beach traffic circle

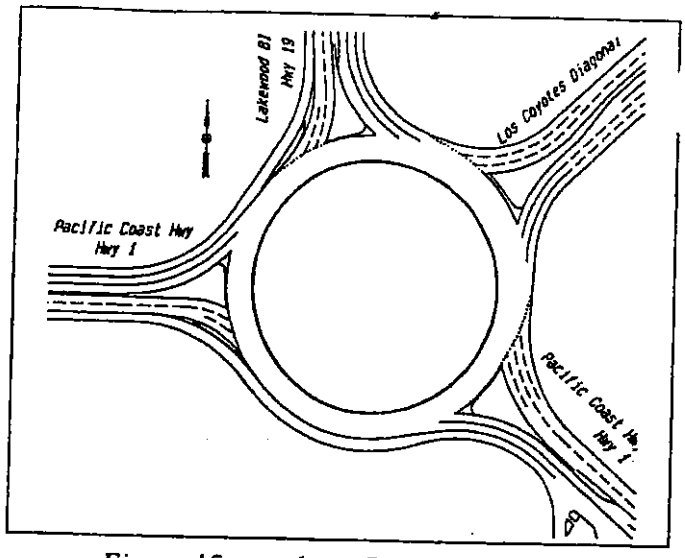


Figure 15, new Long Beach roundabout

Long Beach Roundabout, Long Beach, CA. ICD=470'. PHV=6000 vph. Now under construction, the modern roundabout will replace the old Long Beach traffic circle. Mainly a signing and striping job, the project will not change the outside curblines or the central island. Confusion, anxiety, and accidents will be reduced when the two uncontrolled Pacific Coast Highway entries are regulated by YIELD signs. To reduce congestion, all entries will be widened to three or four lanes by narrowing the splitter islands. As the busiest modern U.S. roundabout likely to be built any time soon, the outcome of this project will influence the course of the roundabout revolution in America. Designers, Ourston and Burnside.

Vermont

This summer Montpelier, the capital of Vermont, will install a modern roundabout as a demonstration project one block from the state house. Federal STP (Surface Transportation Program) grants have been awarded for traffic calming studies in Montpelier and Brattleboro. The studies will consider roundabouts, which improve safety and capacity while calming traffic.

MODERN ROUNDABOUT INTERCHANGES COST LESS

The desire to save money by use of wide nodes and narrow roads has motivated proposals for seven modern roundabout interchanges.

1. The Federal Highway Administration has approved a diamond interchange which will use modern roundabouts at the ramp intersections of Interstate 95 (the Capital Beltway)/Ritchie Marlboro Road (Figure 17). The Maryland State highway Administration selected this design as their preferred alternative. A conventional

FOR MORE INFORMATION, CALL THE DESIGNERS

Burnside, John H., Caltrans District 4, 510 286-5233.

Doctors, Peter J., Penfield & Smith, Santa Barbara, CA 805 963-9532.

Kanely, Brian D., City of Gainesville, Gainesville, FL 904 334-2130.

Henderson, Denise, Rodgers & Associates, Rockville, MD 301 948-4700.

Manu, Philip R., City of Gainesville, Gainesville, FL 904 334-2130.

Myers, Edward J., Hurst-Rosche Engineers, Cockeysville, MD 410 683-1683.

O'Brien, Andrew, Andrew O'Brien & Associates Pty. Ltd., Camberwell, Victoria, Australia. 011613-882-9955.

Ourston, Leif, Leif Ourston & Associates, Santa Barbara, CA 805 683-1383.

Sprague, Ben R., Pentacore Engineering, Las Vegas, NV 702 258-0115.

Wallwork, Michael J., Florida DOT, Jacksonville, FL 904 685-4069.

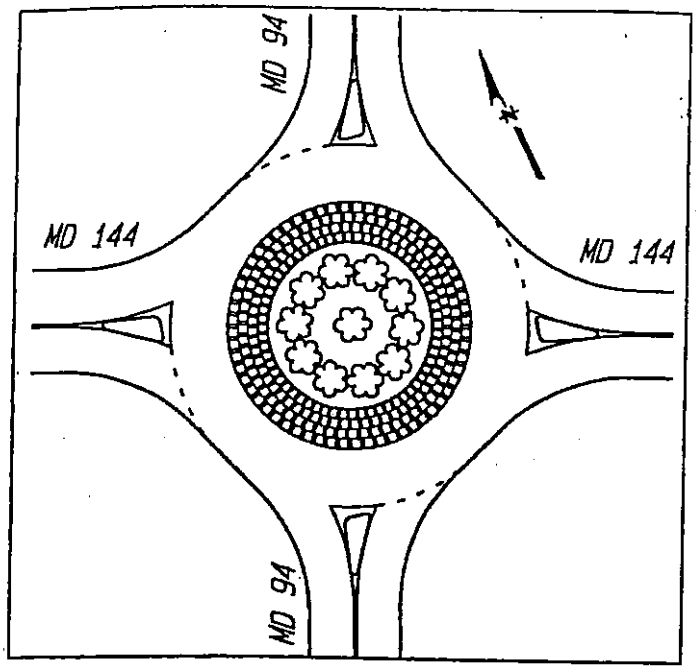


Figure 16

Lisbon Roundabout, Lisbon, MD. ICD=100'. 2010 DHV=1425 vph. To be constructed this spring, this will be the first roundabout on the Maryland state highway system. Designers, Ourston and Myers.

diamond interchange regulated by traffic signals would require widening the existing four-lane undercrossing to six lanes. The modern roundabout interchange will save $10 million while causing roughly one-tenth the delay and one-half the accidents of the traffic signal alternative.

2 and 3. The California Department of Transportation has commissioned a study of the feasibility of using modern roundabouts to increase capacity without overcrossing widening at two Highway 101 interchanges in Ventura County, at Lost Hills Road and at Reyes Adobe Road.

4. A modern raindrop interchange is proposed for Rice Avenue over U.S. Highway 101 in Oxnard, California (Figure 19). This interchange would save the high cost of right of way required by a conventional partial cloverleaf interchange now under study.

5. Osprey Investment Company has funded the study of a roundabout-based interchange which will increase capacity without overcrossing widening

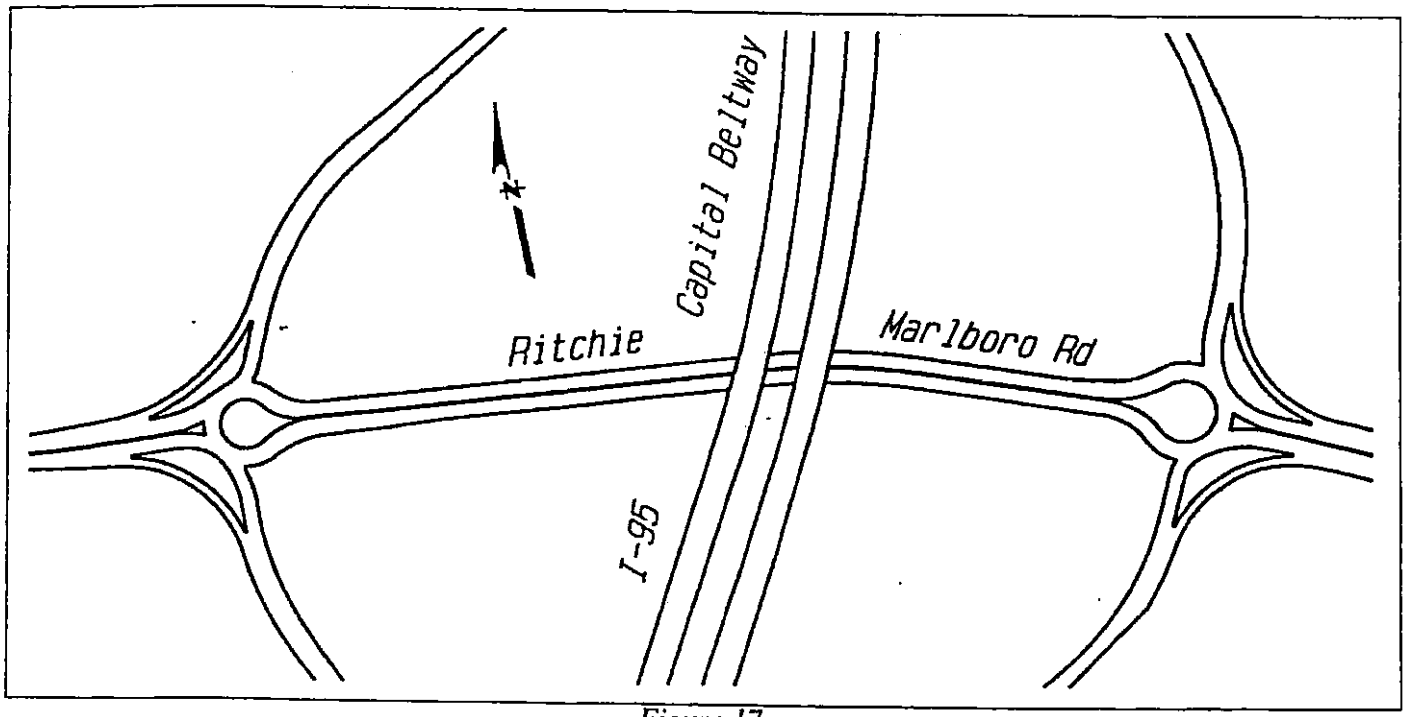


Figure 17

I-95/Ritchie Marlboro Road. ICD=160', west roundabout; 160' and 170', east roundabout. 2010 DHV=5000 vph entering each roundabout. The interchange will use modern raindrop-style roundabouts, which prevent wrong way left turns onto the off ramp, facilitate signalization of the off ramp entry if necessary, and eliminate yield lines for traffic leaving the undercrossing. Since traffic entering the roundabouts from the undercrossing is always moving, the number of lanes under the structure is less than would be required if these lanes were sometimes stopped for red lights as at a signalized diamond interchange. Designers, Ourston and Myers.

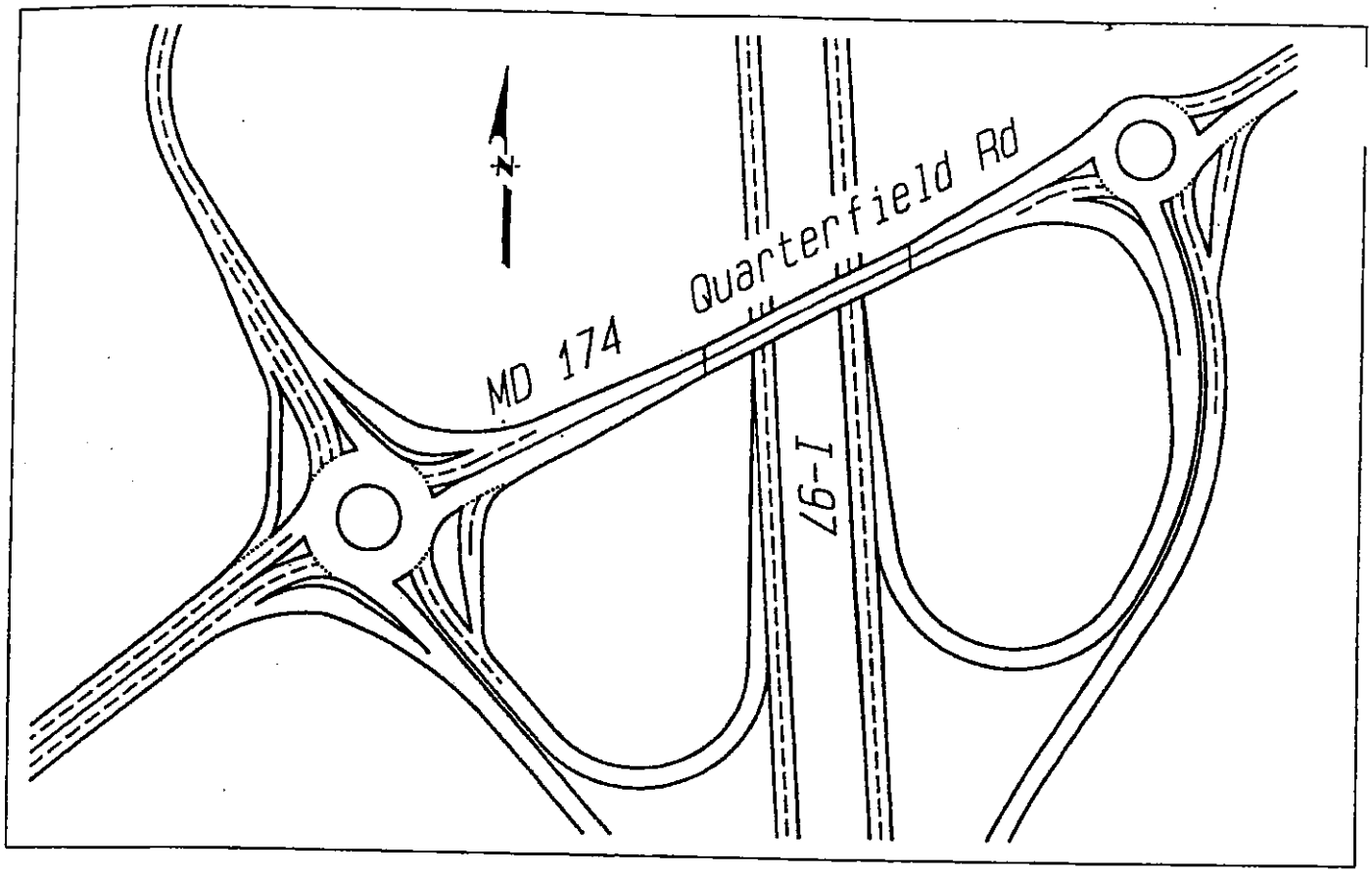


Figure 18

Quarterfield Road/I-97. ICD=150', west roundabout; 120', east roundabout. 2010 DHV=4140 vph entering the west roundabout and 3425 vph entering the east roundabout. The cost of adding roundabouts to the ramp intersections is roughly estimated at $500,000, compared to $20 million for signals and structure widening. Designer, Ourston.

at Quarterfield Road/Interstate 97 in Maryland (Figure 18). This project, if approved, will save nearly $20 million over previously planned interchange modifications, which would have involved widening the grade separation, loop ramps, and traffic signals.

6 and 7. In Santa Barbara, California, modern roundabouts are proposed to improve two U.S. Highway 101 interchanges. At La Cumbre Road (Figure 9) modern roundabouts would save the cost of structure widening and right of way that would be required by a conventional traffic signal alternative. At the north end of the Milpas Street undercrossing a modern roundabout built within existing right of way would eliminate congestion caused by the traffic signal which presently regulates a five-leg intersection (Figure 20).

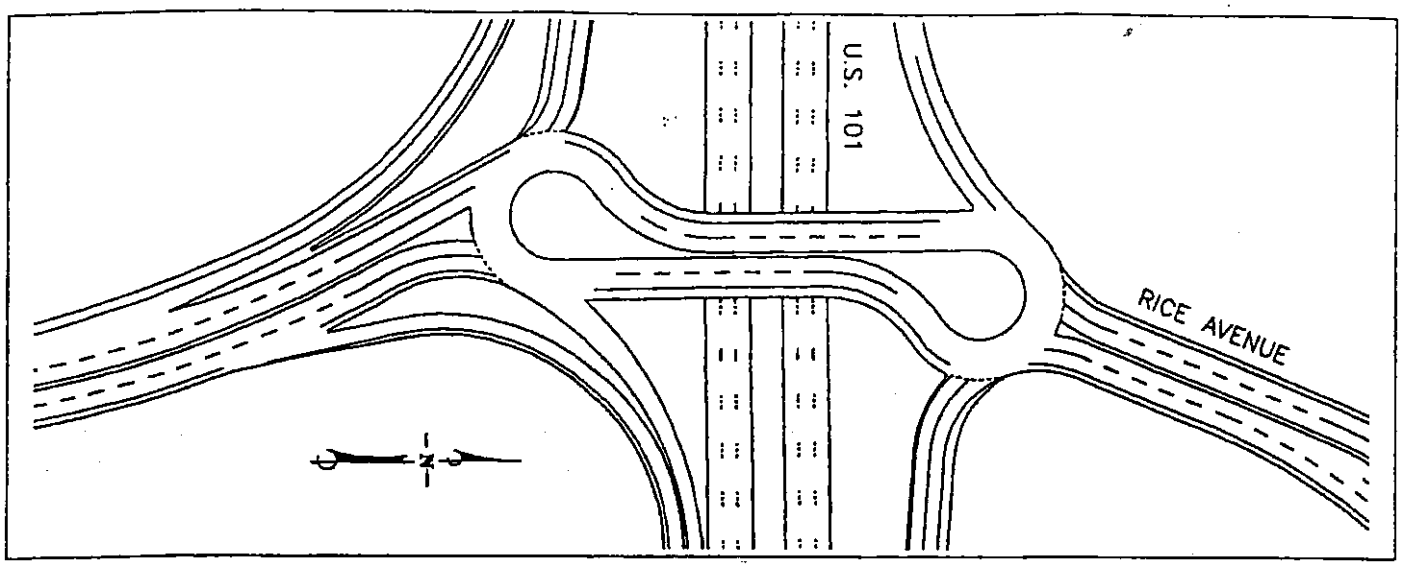


Figure 19

Rice Avenue/U.S. Highway 101, Oxnard, CA. ICD=140'. DHV=4200. Proposed to the City of Oxnard, this raindrop interchange would save expensive land required by a partial cloverleaf interchange now under study. Designer, Doctors.

CONCLUSION

The modern roundabout revolution, which has only recently spread from overseas to America, opens the opportunity for cities, counties, states, and developers to save money between roundabouts by building narrower road links. Of greatest importance are the modern roundabout interchange projects now planned, proposed, and under study, because it is at freeway-to-street interchanges that the most money can be saved, through use of a narrower structure. Nearly all freeway-to-street interchanges in the United Kingdom are based on the modern roundabout, but the United States continues to widen overcrossings and undercrossings at great expense while signalizing ramp and frontage road intersections.

Road systems based on wide nodes and narrow roads are not only more cost effective; they also perform better. Modern roundabouts, the wide nodes, save accidents, time, fuel, and air pollution while improving capacity and providing landscaping opportunities. Narrow link roads are safer and easier for pedestrians and vehicles to cross, and they reduce the amount of land that is sacrificed to pavement.

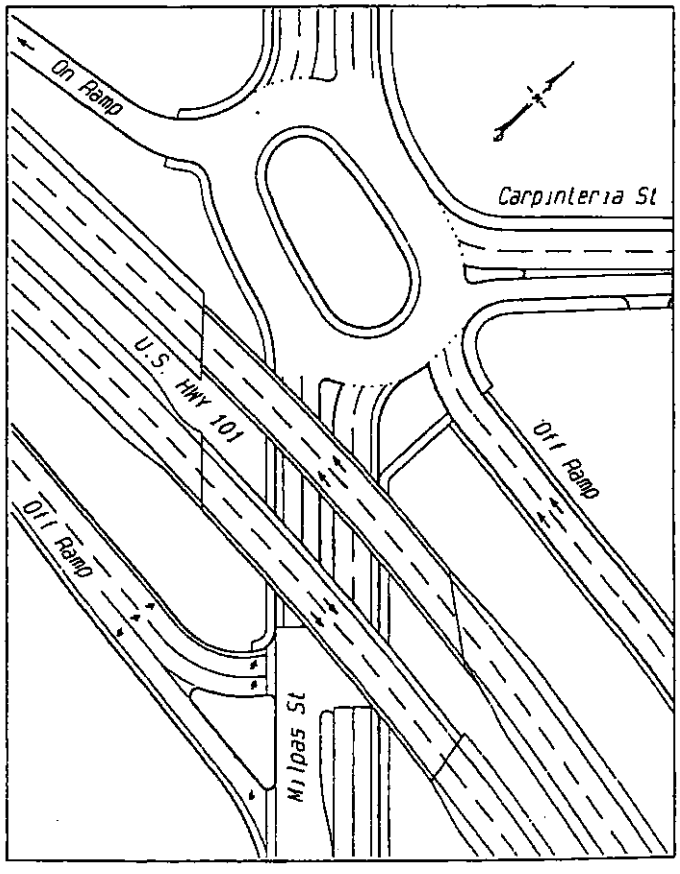


Figure 20

U.S. 101/Milpas St. interchange, Santa Barbara, CA. ICD=120' and 130', each end. PHV=3400 vph. Proposed to the City of Santa Barbara as the lowest cost congestion relief for this five-points ramp intersection. Designer, Doctors.